UNITED UTILITIES WATER

Report on adaptation under the Climate Change Act 2008

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Version	Date	Author	Comments
V1.0	16/09/10	C Bullen	Pre-bronze review
V1.1	17/09/10	C Bullen	Bronze review
V2.1	28/10/10	C Bullen	Pre-silver review
V3.0	23/11/10	C Bullen	Final for silver review
V3.1	30/11/10	C Bullen	Pre-gold review
V3.2	17/12/10	C Bullen	Final for gold review
V4.0	11/01/11	C Bullen	Post gold review
V5.0	20/01/11	C Bullen	Final version post UUW Board approval

KEY MESSAGES

We have a well-established framework for risk management. Climate change is one of many risks to our business and it is managed in the same way as any other.

Sustainable adaptation to climate change will involve partnership working and behavioural change. We expect the proportion of this type of work to increase as conventional solutions become unsustainable.

Climate change risks to our Water Service are well catered for in our existing business plans and statutory documents. We already plan for climate variability in our 25 year business planning horizon.

There are some long-term risks to our Wastewater Service from climate change. Current methods to manage these risks are unsustainable and innovation is needed to manage the issues in the long term.

We are becoming increasingly aware of the risks to our Support Services from climate change. Our adaptation actions are focused around resilience and business continuity.

ES-1. EXECUTIVE SUMMARY

ES-1.1 INTRODUCTION

This report on climate change adaptation has been prepared by United Utilities Water PLC (UUW) in accordance with a direction from the Secretary of State under the Climate Change Act 2008 together with associated Statutory Guidance from Defra.

UUW holds licences to provide water and wastewater services to a population of approximately seven million people in the North West of England. Our business serves domestic and business customers from Cumbria in the north to Cheshire in the south, taking in the sub-regions of Lancashire, Merseyside and Greater Manchester.

The impact of the environment on our activities, and the impact of our activities on the environment, influences how we deliver water and wastewater services to our customers. Consequently any environmental change, in particular climate change, has a significant effect on our business.

This report brings together the work we have done, and plan to do, to adapt to climate change, specifically over the next 25 years, to 2035. This timeframe has been chosen to link with our 25 year business planning timescales.

Wherever appropriate, this report provides a general narrative applicable across our business. However, where we need to explain differences between the main sectors, we have divided the report to reflect the three key main sectors of UUW's business:

- Water services – our reservoir, borehole and river resources, water treatment works and water supply network
- Wastewater services – our network of sewers, wastewater treatment works and sludge treatment and disposal activities
- Support services – human resources, finance, information technology, supply chain, legal services and property management

This split enables the report to highlight the variation in the scale of climate change risk affecting each of these three sectors, as well as reflecting the differences in the regulatory environment, adaptation options and the level of maturity of the adaptation plans for each sector.

ES-1.2 STRATEGIC PLANNING

In our Strategic Direction Statement (SDS), published in late 2007 (updated April 2010) as part of the quinquinial water industry price review process, we set out our vision for our business for the 25 years from 2010 to 2035.

Our approach to climate change adaptation is consistent with our SDS, and is integrated within our strategic asset management planning framework and end to end business process. This framework integrates our SDS, company policies and strategies to develop optimised long-term asset management plans for the next 25 years. The plans provide the foundation for assessing the specific actions required to adapt to climate change risks over the planning horizon and beyond.

Climate change adaptation is embedded within the various business process stages. Climate change data (UKCIP) and assessment of risk is used in the development of company strategies, whilst climate change is accounted for in design, construction and operational activities. The UUW Board have visibility of, and provide input to, all stages of the asset management planning process: from dialogue with stakeholders and endorsement of the key company policies through to the approval of all major capital projects that contribute to customer service, environmental protection and regulatory compliance.

We engage with a wide range of stakeholders to understand their priorities and preferences in relation to our water and wastewater services. This dialogue allows us to develop a detailed understanding of a broad range of our stakeholders' views and plans in order that we can take these into account within our strategic asset planning process.

ES-1.3 BUSINESS PLANNING AND RISK ASSESSMENT

Climate change is one of many risks to our business. Therefore the risks posed by climate change have been assessed in the same way as any other risk that we face.

We assign a likelihood score to each risk based on the probability of occurrence, and a consequence score that takes into account the impact on service provision, environmental, economic, regulatory and legal factors. The overall risk score is calculated by multiplying the likelihood and consequence scores. Risks are then prioritised according to their score. Key risks to our business currently include compliance with regulatory consents, delivery of our capital programme and regulatory issues, together with climate related risks.

Recognising that climate change touches all parts of our organisation, not just the operational assets, we have considered all parts of our business in our climate change risk assessment and adaptation programme.

We have separated our risk assessment and plan into three sections to mirror the main sectors of our business, specifically:

- Water services
- Wastewater services
- Support services

We used data from the CP09 scenarios to undertake our climate change risk assessment exercise, using subject matter experts from within the business. We held workshops for each area of the business. After presenting the CP09 scenarios, facilitated discussions were held at the workshops on potential effects of climate change on our assets and operations to identify the likelihood and consequence scores for each risk. We then identified the adaptation activities already in place that reduce specific risks, and reassessed the risk score where

appropriate. The ongoing adaptation activities for our three business sectors are summarised in section 1.4 below.

ES-1.4 CURRENT ADAPTATION ACTIVITIES

ES-1.4.1 WATER SERVICE

The impacts of climate change on UUW's water service have been considered in our business strategy and planning since 1993 and remains a high priority risk to be managed alongside other risks affecting the water service.

UUW operates an integrated water supply network which provides a high degree of resilience to changes in weather patterns across North West England. The integrated network is integral to UUW's capability to respond to extreme weather events, notably droughts and floods. Increasing the resilience of the water supply system has been a key facet of UUW's investment strategy since the 1995-96 drought. Subsequent extreme weather events have further highlighted the importance of a highly resilient supply system along with robust contingency plans. Resilience also forms the cornerstone of UUW's climate change adaptation strategy for the water service.

Since 1999, UUW has produced a statutory Water Resource Management Plan (WRMP) that details the company's long-term water resource and supply-demand strategy. The WRMP takes into account the potential impact of climate change on the availability of water resources and demand for water, and sets out our plans to ensure reliability of water supplies over a 25-year planning horizon. Our latest plan was published in 2009 and covers the planning period to 2035.

We have also carried out risk assessments to ensure our key water supply assets are adequately protected against climate-related flooding. Actions to protect drinking water quality against climate change effects are focused on catchment land activities. This helps to ensure that raw water quality is maintained prior to treatment.

ES-1.4.2 WASTEWATER SERVICE

In comparison with our water service, climate change has been considered to a lesser extent in business planning and strategy for our wastewater service. Although climate change presents a risk of service failure for both our water and wastewater services, the difference in approach reflects the potential consequences of service failure. Failure of the water service poses a threat to human health whilst failure of the wastewater service poses a threat to property or aquatic life. Therefore it is appropriate that our adaptation to date has been centred on securing the water service against the future impact of climate change.

Climate change adaptation in our wastewater business is currently centred on the sustainability of the public sewerage system and the part it plays in the overall drainage system. Many existing drainage systems currently experience problems of flooding and pollution of the environment, which will be exacerbated by climate change.

In our SDS, we set out the challenges relating to drainage in the North West over the next 25 years. In the past, UUW has responded to flooding by designing and constructing local solutions that increase the capacity of the sewerage system. However, sewerage and other drainage systems cannot be sustainably or cost-effectively designed to accommodate all potential rainfall events. As such, some sewer flooding will inevitably occur when the system is overwhelmed.

Increasing emphasis must therefore be put on demand management approaches to addressing flooding risk by limiting the input of storm water to the drainage system. This will be achieved through the use of integrated drainage, source control and sustainable drainage systems (SUDS). The Pitt Review highlighted the importance of managing surface water effectively, and pointed out the consequences for local communities if this does not occur.

Flooding from the sewerage system is often simply one of the symptoms of more widespread problems in an entire drainage system which will often require actions from other stakeholders as well as water companies, such as United Utilities.

We support the adoption of a joined-up approach to drainage management based on the principles of integrated drainage as outlined in Making Space for Water (Defra, 2005)[1], Future Water (Defra, 2008)[2], the Pitt Review (Sir Michael Pitt, 2008)[3] and Flood and Water Management Act (2010)[4].

We believe that the adoption of an integrated drainage approach will provide an improved, more cost-effective and sustainable service to our customers, and will provide protection from increasing rainfall intensity resulting from climate change. We consider that the development of Surface Water Management Plans (SWMPs) will be the key enabler for the sustainable management of surface water, and we are actively engaged with local authorities and the Environment Agency in the promotion and development of SWMPs in the North West of England.

ES-1.4.3 SUPPORT SERVICES

UUW's business support services comprise Information Technology (IT), Human Resources (HR), Supply Chain, Legal, Finance, Communications and Property services. Our current approach to adapting these services to the impacts of climate change is undertaken as part of resilience and 'business continuity' planning.

ES-1.5 SUMMARY OF CLIMATE CHANGE RISK

The level of residual climate change risk in 2035 following completion of our current adaptation plans is given in Figure ES-1. The risks have been sub-divided into those relating to our three key business sectors, and are categorised by the seriousness of the risk to our business, and hence the adverse effect on our customers or the environment. The risks in the red coloured quadrant are considered the highest priority.

[1] http://www.defra.gov.uk/environment/flooding/documents/policy/strategy/strategy-response1.pdf
[2] http://www.defra.gov.uk/environment/quality/water/strategy/pdf/future-water.pdf
[3] http://webarchive.nationalarchives.gov.uk/20100807034701/http://archive.cabinetoffice.gov.uk/pittreview/thepittreview/final_report.html
[4] http://www.legislation.gov.uk/ukpga/2010/29/pdfs/ukpga_20100029_en.pdf

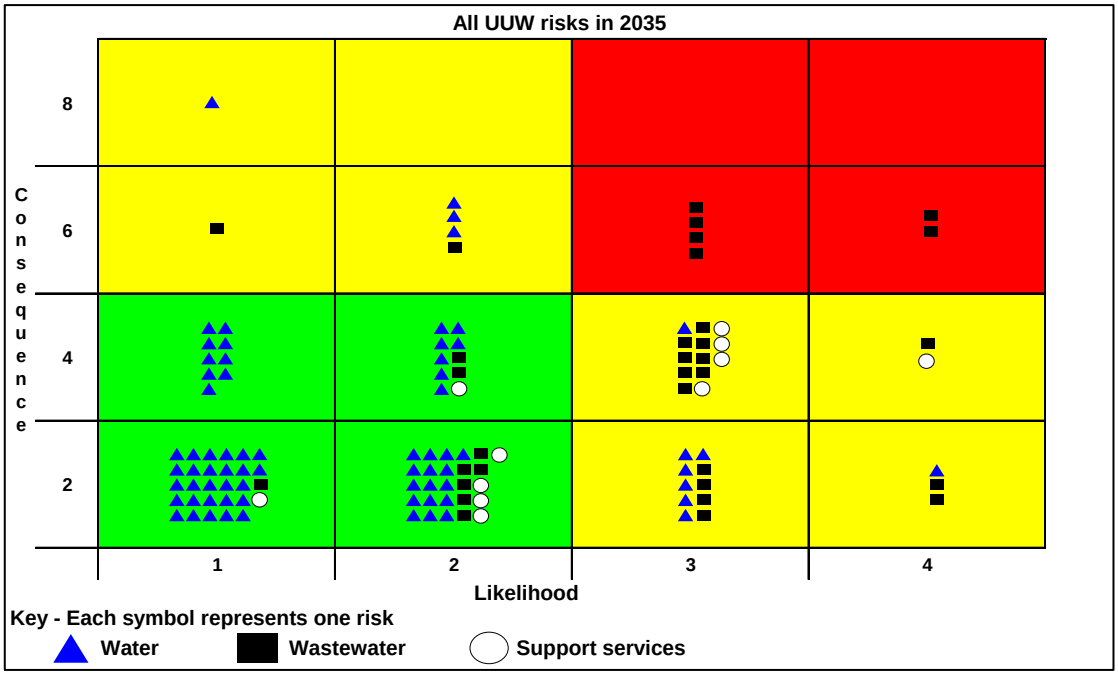


Figure ES-1 UUW residual risks from climate change in 2035

The high priority 'red' risks, together with the adaptation activity currently underway are described in Table ES-1 below.

Table ES-1

Summary of high priority (red) climate change risk	Adaptation activity currently underway and benefits to be achieved
Increased volumes of storm water exceed sewer capacity and causes customer flooding.	Upsize priority sections of sewer to alleviate local sewer flooding together with the provision of protection to customers' property (flooding mitigation) to prevent entry of sewage.
	Undertake improvements to our hydraulic models of the sewer network. This will allow a detailed understanding of the impacts of supply/demand changes, including climate change, on our sewerage network.
	Actively engage with local authorities and the Environment Agency in the promotion and development of SWMPs in the North West of England. The production of SWMPs will allow for the integrated understanding of the cause of surface water flooding in a specific locality and the development of the most cost-effective programme of measures to manage that surface water flood risk.
	Continue with our Integrated Catchment Asset Planning approach. We will prioritise wastewater treatment works (WwTWs) and drainage networks according to their relative exposure to the impact of climate change. This will allow us to address spatial variation in changes in rainfall patterns by targeting investment needs and ensure holistic and sustainable solutions are progressed.
Loss of power to WwTW and consequent loss of the treatment process	Work with our energy supplier to identify critical sites and develop a plan to manage the risk of outages and service failure. We will put plans in place to manage the risk of power outages, including use of combined heat and power systems, at critical sites. These

Summary of high priority (red) climate change risk	Adaptation activity currently underway and benefits to be achieved
resulting in pollution of the environment.	will be linked to business continuity/resilience plans.
Direct asset flooding of WwTW, sewerage pumping stations and sludge treatment facilities (3 separate risks), leading to asset loss and service failure.	Develop flood risk plans for all sites through asset planning. Use CP09 scenarios to review climate change risk assessment and adaptation plans as part of ongoing asset planning. Identify level of risk of sites to flooding and prioritise sites according to their current level of risk. Produce a plan to reduce the risk at the highest priority sites. Ensure that adaptation activities address the appropriate risks of climate change.
Direct asset flooding, storm damage and coastal erosion or planned retreat resulting from sea level rise, leading to asset loss and service failure.	Develop plans for sites at risk from sea level rise through asset planning. Identify level of risk of sites and prioritise sites according to their current level of risk. Produce a plan to reduce the risk at the highest priority sites.
Reduced base flow in receiving water courses leading to tighter discharge conditions. Increased risk of consent failure and pollution.	Undertake Integrated Catchment Modelling (ICM) work with the EA to identify future water quality improvements required by legislation alongside the potential effects of climate change on base flows in receiving watercourses. Investigate solutions to relieve the impact of rapid variation in inflows/dilution to WwTWs. This will allow us to identify investment needs and manage the impact of changing patterns of precipitation leading to a reduction in treatment process performance efficiency.

ES-1.6 UNCERTAINTIES AND ASSUMPTIONS

Our climate change risk assessments and associated adaptation plans are underpinned by data that necessarily exhibits a wide range of uncertainty due to the difficulties inherent in climate modelling and forecasting.

The risks and plans become even more uncertain when the forecasts are scaled to a more local catchment level. It is particularly difficult to translate climate change forecasts for rainfall and temperature to second and third order effects such as flooding and drought at the catchment scale. Therefore, we have had to take account of uncertainties in the climate forecasts and make assumptions to support the risk assessment and adaptation plans.

The key assumptions made are:

- Climate change in the North West England region will continue to be relatively gradual, rather than materialise in a catastrophic step-change event.
- The current structure of the water industry in England and Wales remains unchanged.
- UUW remains a privately-owned company with a mixed debt/equity funding structure, and is able to access the debt/equity markets to finance the expenditure required to adapt to climate change.

- UUW will continue to work in partnership with other utility companies and the public sector on integrated drainage and Surface Water Management Plans.
- Exisiting emergency planning and response capabilities of Category 1 and 2 responders (as defined in the Civil Contingencies Act 2004) remain in place.

Through the production of this report we have identified:

- Uncertainties, such as those inherent in the underlying climate change predicitions.
- Barriers, such as affordability of the adaptation activities.
- Interdependencies, such as knowledge of other sectors' risks and adaptation plans.

Where appropriate, we have identified mitigating actions to resolve these issues.

ES-1.7 MONITORING AND EVALUATION

Climate change risk is already an integral part of our business risk and asset planning processes. The effectiveness of each action listed in our adaptation plan will be evaluated when the risk assessment process is updated (i.e. current risks should have a substantially lower score or be removed if the action has been successful). This method of evaluation is in line with a continual cycle of risk assessment and action. The company will continue to report on progress with climate change adaptation plans to its key regulators on an annual basis. We will update this report by mid-2015 and provide a copy to Defra.

ES-1.8 COMPLIANCE WITH THE STATUTORY GUIDANCE

This report has been produced in line with the Defra's statutory guidance to reporting authorities.

This report addresses the seven areas as outlined in Box 2[5] of the guidance. However, the headings and flow of this report are designed to be more of a narrative of our current and future plans than simply providing answers to the 27 questions.

Therefore, to allow the linkages to Defra's statutory guidance and Cranfield's evaluation framework to be mapped to this document we have included the table below.

[5] Defra (2009) Adapting to Climate Change: helping key sectors to adapt to climate change. Statutory guidance to reporting authorities.

Defra statutory guidance	Relevant section of this UUW report
Box 2 1a	2
1b	4
1c	4, 8
1d	2
Box 2 2a	3, 4
2b	4
2c	5
Box 2 3a	4
3b	4
3c	4, 5
3d	5
Box 2 4a	4, 5
4b	5
4c	5
4d	4
4e	3, 4, 8
Box 2 5a	6
5b	6
Box 2 6a	7
6b	7
6c	7
Box 2 7a	8
7b	8
7c	5, 8
7d	3, 4, 8
7e	3, 5, 8
7f	4

Cranfield evaluation framework Key & sub attributes	Relevant section of this UUW report
1.1	3, 4
1.2	4
1.3	5, 8
1.4	6, 7
1.5	3
2.1	4
2.2	4
2.3	4
2.4	4
2.5	4
2.6	4
3.1	3, 4
3.2	3, 4
3.3	3, 4, 6, 7
4.1	3, 4, 5, 6
4.2	5, 6
4.3	6
5.1	4, 5
5.2	4, 5
5.3	4, 5
5.4	5, 8
6.1	5
7.1	3, 5, 8
7.2	6, 7
8.1	3, 4
8.2	4, 5, 8
8.3	4, 5, 8
8.4	4, 5, 8
8.5	8

1 INTRODUCTION

1.1 STRUCTURE OF THIS REPORT

1. Wherever appropriate, this report provides a general narrative applicable across our business. However, where we need to explain differences between the main sectors, we have divided the report to reflect the three key main sectors of UUW's business:

    - Water Services
    - Wastewater Services
    - Support Services

This enables the report to highlight the variation in the scale of climate change risk affecting each of these three sectors, as well as reflecting the differences in the regulatory environment, adaptation options and the level of maturity of the adaptation plans for each sector.

Where there are common themes across our business activities, we discuss them concurrently.

1.2 RESOURCES

We estimate that the time taken to produce this report, including the associated workshops and business review sessions, is around 1300 hours. This equates to 66% of an annual full time equivalent. All the individuals involved in the production of this report are full time employees of United Utilities Water.

2 INTRODUCTION TO UNITED UTILITIES WATER

2.1 FUNCTIONS, AIMS AND OBJECTIVES

United Utilities Water PLC (UUW) holds licences to provide water and wastewater services to a population of approximately seven million people in the North West of England. We employ around 4,600 staff.

Figure 1: United Utilities Water operational area within the UK

Our business serves the population and businesses of the North West of England, from Cumbria in the north to Cheshire in the south, taking in the sub-regions of Lancashire, Merseyside and Greater Manchester.

We meet the population's needs for clean, safe, reliable supplies of drinking water providing an essential public health service. We remove wastewater from our customers' homes and businesses, returning it safely to the water environment. This service requires a network of some 40,000 kilometres each of mains and sewers, some 95 water treatment works and 575 wastewater treatment works. The network we operate and maintain is the largest integrated water network in the UK. We operate an extensive customer service operation using, for the most part, call centres based within our region, in particular in Warrington and Whitehaven.

Since privatisation in 1990, our investment has brought significant benefits to the region: drinking water quality has been improved; reliability of supplies has been enhanced; the region's rivers and bathing waters are at their cleanest for several generations.

Consistent with our approach to longer-term planning, UUW's Water Resource Management Plan, published in September 2009[6], considers the water supply/demand balance in the North West of England, including the potential impacts of climate change out to 2035 and in the longer term.

[6] http://www.unitedutilities.com/WaterResourcesPlan.aspx

Our Strategic Direction Statement[7], which was updated in April 2010, sets out the company's plans and strategic aims for the period 2010-35. The key elements identified in our Strategic Direction Statement are:

- Demonstrating responsible stewardship of the water and wastewater networks we operate;
- Listening to what our customers and other stakeholders tell us;
- Ensuring our water resources are more sustainable and resilient;
- Following an integrated approach to drainage to reduce the threat of flooding;
- Reducing significantly the carbon impact of our activities; and
- Aiming to achieve this without adding to the burden on household budgets.

The Strategic Direction Statement is consistent with the UKCIP02 climate change projections. The CP09 projections were not available at the time of producing the Statement. Whilst the risk assessment and future adaptation work proposed in this report are based on the recent CP09 projections, the publications of the Strategic Direction Statement, Water Resource Management Plan and Company Business Plan[8] predate this information and therefore utilise UKCIP02.

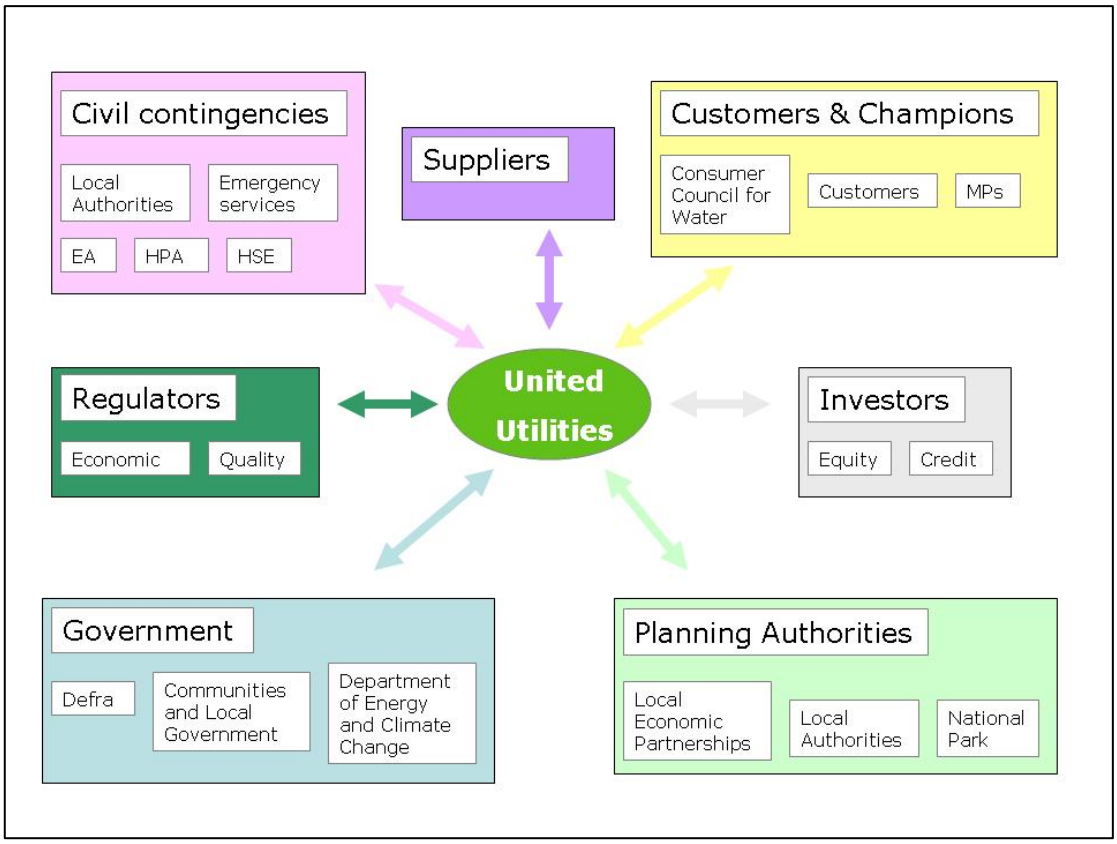
[7] United Utilities Water (2007, updated 2010) Strategic Direction Statement 'Where we are heading'. http://www.unitedutilities.com/Documents/Strategic_Direction_Statement_-_update_April_2010.pdf

[8] United Utilities (2009) United Utilities Business Plan 2010-2015. Planning for the future. http://www.unitedutilities.com/Documents/Detailed_plan.pdf

2.2 OUR KEY STAKEHOLDERS

We regularly engage with a wide range of stakeholders to understand their priorities and preferences in relation to our water and wastewater services. This dialogue allows us to develop a detailed understanding of a broad range of our stakeholders' views and plans in order that we can take these into account within our strategic asset planning process. Our key stakeholder groups are summarised in Figure 2.

Figure 2: UUW's Key External Stakeholders



We engage closely with our principal economic and quality regulators on climate change issues: the Water Services Regulation Authority (Ofwat), the Drinking Water Inspectorate (DWI), the Environment Agency (EA) and Natural England. We also work in partnership and support a wide range of statutory and non-statutory environmental bodies, for example the Royal Society for the Protection of Birds (RSPB), National Park Authorities and Groundwork, - where we can jointly improve the environment for the benefit of our customers.

To ensure that we understand the future plans and development requirements in North West England, we liaise with the 42 District, Unitary and County Councils together with the three National Park Authorities within our region. We have had links with Government Office North West to understand the eco-town and growth point initiatives and the impact these could have on the services we provide in the North West. We are aware that the Government Office North West will close before the end of this financial year and are waiting to hear plans for the transfer of functions.

We engage with Defra on a wide range of future planning issues which includes participating in pilot work, responding to consultations and providing outline cost and impact information to inform decision making. This has included recent work on integrated urban drainage, along with contributions to the development of "Future Water[9]" and to the Pitt Review[10] [11] on flood risk management.

There is a programme of regular investor meetings and presentations which take place throughout the year, both in the UK and overseas. Such briefings, together with regular announcements of significant events affecting the company and frequent updates on current trading, are part of a dedicated investor relations programme to keep the company's equity and credit investors well informed. In addition, the Board commissions an annual survey of shareholders to maintain an understanding of investors' views and priorities.

[9] Defra (2008) Future Water – The Government's water strategy for England http://www.defra.gov.uk/environment/quality/water/strategy/pdf/future-water.pdf

[6] Defra (2008) The Government's response to Sir Michael Pitt's review of the summer 2007 floods http://www.defra.gov.uk/environment/flooding/documents/risk/govtresptopitt.pdf

[11] (2008) "Learning lessons from the 2007 floods" an independent review by Sir Michael Pitt http://webarchive.nationalarchives.gov.uk/+/http:/www.cabinetoffice.gov.uk/thepittreview/final_report.aspx

3 OUR APPROACH TO CLIMATE CHANGE ADAPTATION

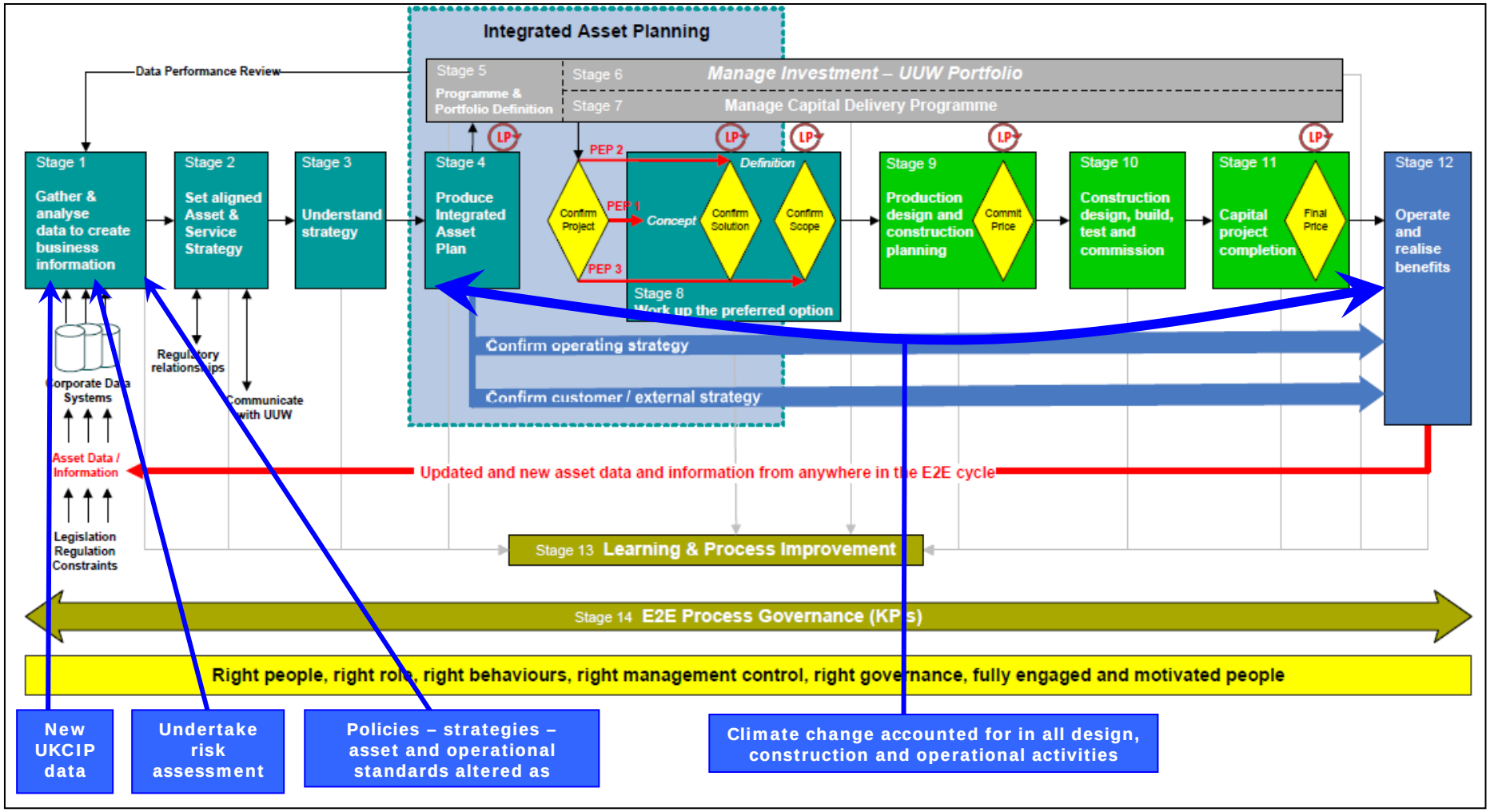
3.1 RESPONDING TO THE DIRECTION TO REPORT ON ADAPTATION UNDER THE CLIMATE CHANGE ACT 2008

In February 2010, UUW received a Direction from the Secretary of State to prepare a report about the impact of climate change on our functions and policies, and our proposals for adaptation. This report brings together all the work we have carried out, and plan to do, to adapt to climate change, specifically over the next 25 years, up to 2035. This timeframe has been chosen to link with our 25 year business planning timescales. We have inferred the climate change predictions to 2035 to link with these timescales. However, our adaptation plans only extend up to 2020 owing to the uncertainties in regulatory timescales and funding that would agree these beyond 2020.

Our approach to climate change adaptation is consistent with our Strategic Direction Statement[7] (SDS) and is integrated within our strategic asset management planning framework and end to end business process (Figure 3). This framework integrates our SDS, company policies and strategies to develop optimised long-term asset management plans for the next 25 years. The plans provide the foundation for assessing the specific actions required to adapt to climate change risks over the planning horizon and beyond.

Figure 3 below outlines our end-to-end business process. It shows how climate change adaptation is embedded within the various process stages. The UUW Board have visibility of all stages and provide input as required at all stages of the asset management planning process, from dialogue with stakeholders and endorsement of the key company policies through to the approval of all major capital projects that contribute to maintaining or enhancing customer service, environmental protection and regulatory compliance. Figure 3 shows how climate change adaptation is embedded within the various process stages. As new climate or other data becomes available the risk assessment process is undertaken. This may highlight a need to alter existing policies, strategies and asset standards. Ensuring that our policies, strategies, asset standards and similar documents take account of climate change impacts means that all future construction and operational activities will automatically have adaptation built in to them.

Figure 3: UUW's strategic planning and end to end business processes



3.2 HISTORICAL PERSPECTIVE

The environment is central to our core activities of supplying potable water and of managing wastewater. Consequently, we are susceptible to environmental change and we are acutely aware of the threat to our activities presented by climate and the changes to it. Together with other water companies in the UK, we have funded collaborative research (often with Ofwat and the Environment Agency) to provide the best available scientific information to support climate change risk assessment and inform adaptation planning.

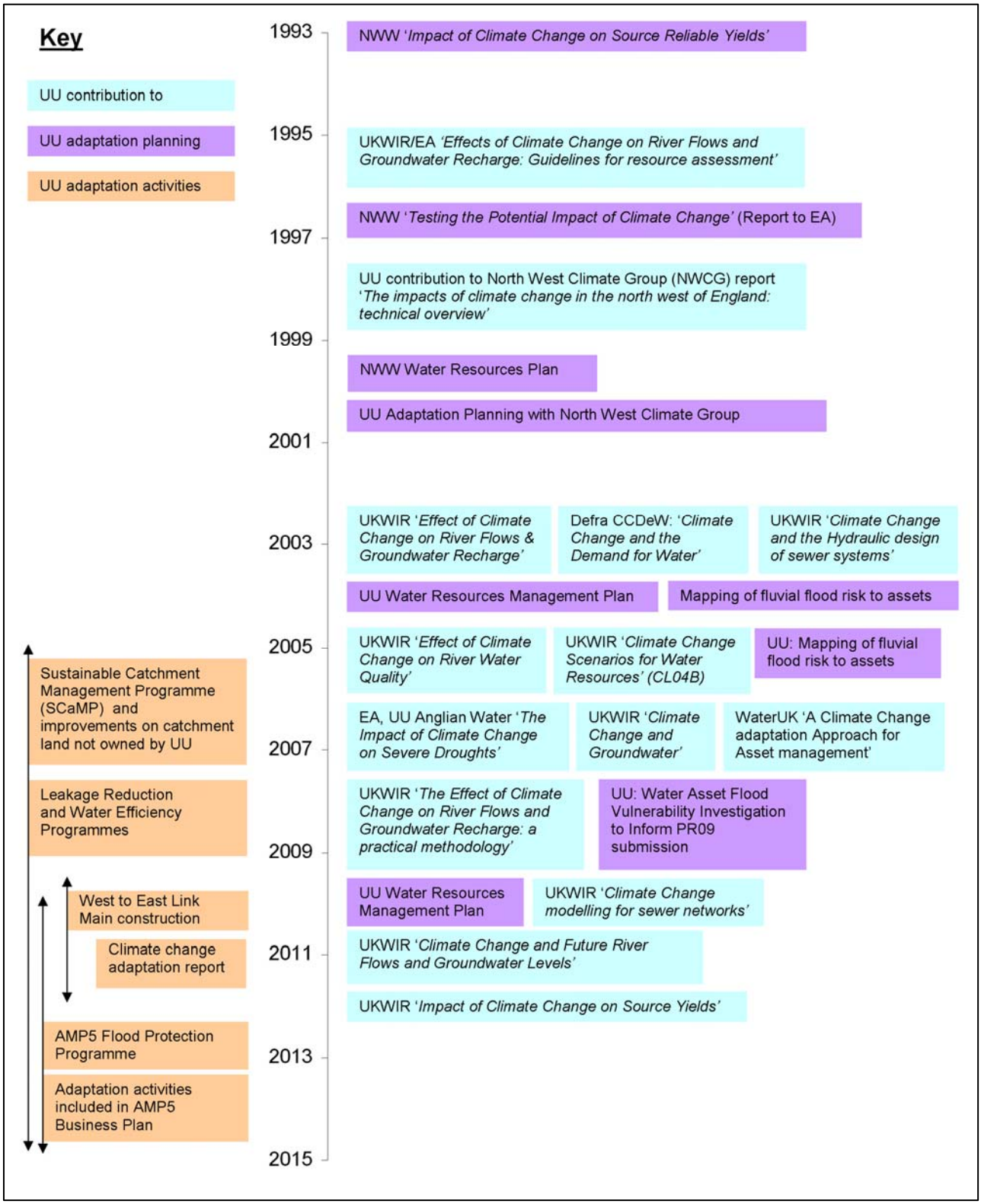
Figure 4 summarises our action on climate change risk assessment and adaptation planning to date.

It is evident that our adaptation programme is more developed in some areas of the business than others. For instance, our climate change risk assessments adaptation plans for water resources date back to 1993. Our latest views and plans are well documented in our 2009 statutory Water Resource Management Plan[6] (WRMP). This takes into account the potential impact of climate change on the availability of water resources and the supply-demand balance. Similarly, the company is developing detailed plans from a resilience and business continuity point of view for its information infrastructure, given the vital service telecommunications and data systems play in operating our business.

By contrast, there has been less direct work on developing specific adaptation plans to climate change for the wastewater business. This is largely because, to date, there has been a high degree of uncertainty of the scale, impact and timing of climate change. Consequently, it has been difficult to justify investment in specific adaptation plans via the regulatory price setting mechanism. One of the key elements of our current policy on climate change adaptation for wastewater is to take an integrated approach to managing surface water that deals with drainage in the most sustainable manner. We do not believe that it is sustainable to upsize assets to increase their capacity to deal with increased storm intensities arising from climate change. Furthermore, the impact of changing rainfall patterns will vary across the region, which presents challenges in planning the particular location and timing of adaptation actions.

Our policy is to move away from individual solutions, such as up-sizing sections of sewer, towards a more holistic approach to managing urban drainage. The aim will be to help manage the demand on our wastewater networks by promoting water conservation and integrated urban drainage. This is in line with the approach to managing surface water developed post the Pitt Review.

Figure 4: Timeline of our previous and current action on climate change risk assessment and adaptation planning



Our experience of extreme weather events over the past 15 years is detailed in Table 1. These events have provided very real experience of the impact that climate change could have on our services. Indeed, the 2010 drought was local to the North West region and UUW was the only water company to impose hosepipe restrictions. These experiences have enabled us to develop robust contingency plans for such extreme weather conditions which form part of our adaptation programme.

Table 1: History of climate related events experienced by UUW since 1995

Date	Event	Service affected	Impact	Learning
1995-1996	Drought	Water	During April 1995 – October 1996 only 67% of long term average rainfall was received. High temperatures exacerbated the situation and record peak demand caused localised problems of low pressure. A hosepipe ban was imposed with drought orders to restrict non essential use. North West Water obtained 19 drought orders and 9 drought permits.	Customer service standards for water supply reliability were significantly improved through £400m investment in leakage reduction, increased water supply system resilience and enhancements to water sources. Development of 25 year, long-term water resource plans and risk allowances for outages and planning uncertainties. North West Water developed the first drought contingency plan which was subsequently used as the template for national drought planning guidelines.
Winter 1995-1996	Freeze-thaw	Water	Water within customer supply pipes and internal pipe work at customers' properties froze then thawed rapidly leading to major increase in leakage and a temporary loss of supply in some supply zones.	Introduced an annual cold weather action plan to ensure a more resilient response to any future freeze-thaw event, including ground frost forecasts from the Met Office. Introduced customer education campaign to advise customers how to reduce the risk of pipe bursts at their properties.
1996	Rain following drought	Water	A high turbidity event associated with the Kinder Reservoir Catchment led to a temporary shut-down of Wybersley Water Treatment Works.	Events like this highlight the need to ensure that customers can be supplied by more than a single treatment works and the importance of catchment improvements to raise the water table and hence reduce the drying of the peat.
November 2000	River Dee Flood	Water	A near-miss of flooding at Huntington WTW which supplies large parts of Cheshire and Merseyside.	Investigation into flood protection required at strategic sites. Completion of a flood defence structure to protect the Huntington WTW river pumping station.

Date	Event	Service affected	Impact	Learning
2003	Drought	Water	Prolonged dry period. UUW applied for drought powers but did not have to implement them because the situation recovered.	Further improvements to UUW statutory drought plan, principally environmental impact studies for drought permits.
January 2005	Flooding	Wastewater	Flooding in Carlisle as a result of high rainfall and tidal surge.	46 individual areas for improvement identified in post incident review. Highlighted previously unidentified problems in the sewerage system and under high river conditions. These issues now resolved.
2009	Flooding	Wastewater	Flooding in Cumbria. 63 wastewater sites flooded, access routes flooded, loss of power supply, properties flooded, landslip into Thirlmere reservoir.	20 individual areas for improvement identified in post incident review. Pre-incident preparation actions (learned from 2005 incident) paid dividends.
January 2010	Freeze-thaw	Water	Water within customer supply pipes and internal pipe work at customers' properties froze then thawed rapidly leading to major increase in leakage	Learning from 1995/96 freeze-thaw event meant that there was no loss of supply to customers and leakage levels reduced more rapidly.
January 2010	Snow and ice	Support Services	Travel restricted for many employees. Remote IT access overwhelmed.	Remote IT access system must have sufficient capacity to enable the vast majority of employees to work remotely. Issue now resolved as part of our Business Continuity planning work.
2010	Drought	Water	During December 2009 – June 2010 only 57% of long term average rainfall was received. Drought plans were followed and a hosepipe ban was imposed for 6 weeks.	A lessons learnt exercise has been undertaken with the EA and other key stakeholders to identify areas of improvement. These will be incorporated into UU's update of its statutory drought plan in 2011. Changes in legislation, such as the Flood and Water Bill will also be incorporated into the updated plan.
July and August 2010	Flooding	Wastewater	Severe weather (intense rainfall) led to the internal flooding of 771 properties across the North West region.	Highlighted the importance of working together with the Local Authorities during the incident. Emphasised the need for Surface Water Management Plans to the LAs.
December	Freeze-	Water	Water within customer supply pipes and internal pipe work at	Learning from Jan 2010 freeze-thaw event meant that

Date	Event	Service affected	Impact	Learning
2010	thaw		customers' properties froze then thawed rapidly leading to major increase in leakage increasing	there was no loss of supply to customers and leakage levels are reducing rapidly.

3.3 CURRENT ADAPTATION IN OUR WATER BUSINESS

The impacts of climate change on UUW's water service have been considered in our business strategy and planning since 1993 (Figure 4) and continues to remain a high priority risk to be managed alongside other risks affecting the water service.

UUW operates an integrated water supply network which provides a high degree of resilience to changes in weather patterns across North West England. The integrated network is integral to UUW's capability to respond to extreme weather events (Table 1), notably droughts (e.g. summer 2010) and floods (e.g. the Cumbrian floods in November 2009), but also "freeze-thaw" events (e.g. January 2010). Increasing the resilience of the water supply system has been a key facet of UUW's investment strategy since the 1995-96 drought, and subsequent extreme weather events have further highlighted the importance of a very resilient supply system along with robust contingency plans. Resilience also forms the cornerstone of UUW's climate change adaptation strategy for the Water service.

Since 1999, UUW has produced a Water Resource Management Plan[6] (WRMP) that details the company's long-term water resource and supply-demand strategy. The WRMP takes into account the potential impact of climate change on the availability of water resources and demand for water, and sets out our plans to ensure reliability of water supplies over a 25-year planning horizon. Our latest plan was published in 2009 and covers the planning period to 2035. It is publicly available on our website[6].

We have also carried out flood risk assessments to ensure our key water supply assets are adequately protected, including dams. Catchment management practices have been adopted to reduce future drinking water quality issues in high risk areas.

Figure 5 provides an overview of the current activities that we undertake to assess the impacts of climate change across the 'source to tap' supply chain and develop an integrated adaptation strategy. Further details of our current climate change adaptation strategy are provided below.

3.3.1 WATER RESOURCE MANAGEMENT PLAN

For the climate change risk assessment within the 2009 WRMP, UUW used the most up-to-date climate change scenarios available at the time, the "UKCIP02" scenarios[12], and the methodology developed collaboratively by the Environment Agency (EA) and UK Water Industry Research (UKWIR) [13] [14] [15]. Appendix B details the methodologies we used to produce the climate change impact scenarios for groundwater levels, river flows and reservoir inflows.

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[12] UK Climate Impacts Programme (2002) Climate Change Scenarios for the United Kingdom: The UKCIP02 Scientific Report.

[13] UKWIR (2006) Effect of climate change on rivers flows and groundwater recharge: a practical methodology

[14] UKWIR (2007) Effect of climate change on rivers flows and groundwater recharge: guidelines for resource assessment and UKWIR06 scenarios

[15] UKWIR (2007) Effect of climate change on rivers flows and groundwater recharge: a practical methodology for draft recharge and groundwater level impact assessment

We assessed the potential impact of climate change on the future demand for water following the water resource planning methodology for component-based demand forecasting[16] together with data from Defra (2003)[17].

The effects of climate change on flows and demand were modelled using UUW's sophisticated water resource modelling tools to determine the consequent impacts on the reliable yields (or deployable outputs) of our water sources and on levels of service to customers (as measured by the frequency and duration of hosepipe bans, drought permits and restrictions on non-essential water use).

This approach to assessing climate change impact is fully aligned and integrated within UUW's Water Resources Management Planning framework and is based on the UK water industry's approach to water resources planning and the guidance issued by the EA[16].

Climate change risks were incorporated into the company's "Headroom" assessment (an allowance for planning uncertainties), following the water industry standard approach and methodologies[18]. UUW assessed the predicted supply-demand deficiency over the planning horizon (25 years) including the planning uncertainty allowances (or "headroom" allowance). By incorporating climate change risk into the "headroom" allowance, we have approached climate change risks in the same way as the other risks and uncertainties associated with long-term water resources planning.

A range of options were then appraised to address the forecast supply deficit using industry-wide option appraisal methodologies[19], including environmental and social costs, we have developed a water resources and demand strategy which takes into account the potential impact of climate change on the availability of water resources and the supply-demand balance. Our "twin-track" supply and demand strategy includes demand management activities (increased optional metering penetration, leakage reduction and water efficiency activities), increased resilience of the water supply network and the phased development of new groundwater sources (which are the most resilient sources to climate change in North West England).

It should be noted that demand reductions as a result of increased customer metering have been included in the demand forecast calculations. In accordance with the consultation response from Ofwat on our Draft WRMP, this excludes compulsory metering of existing unmeasured homes. However, we anticipate that in the longer term it will become a statutory requirement to meter all homes; this is consistent with UU's Strategic Direction Statement (2009)[7].

In accordance with the Water Resources Management Plan Regulations[16], we consulted with our customers and stakeholders on a draft of our WRMP during 2008. The Draft WRMP was published on the company's website and issued to 81 statutory consultees and 116 non-statutory consultees. A total of fourteen formal representations on the Draft WRMP were submitted to the Secretary of State. The 2009 Final WRMP has incorporated the comments received from consultees following advice from regulators and taking account of new information mentioned by consultees that has become available since production of the original Draft WRMP.

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[16] Environment Agency (2008) Water Resources Planning Guideline

[17] Defra (2003) Climate Change and the Demand for Water (CCDeW).

[18] UKWIR (2002) An Improved Method for Assessing Headroom

[19] UKWIR/EA (2002) Economics of Balancing Supply and Demand (EBSD)

Case study Box 1 details the company's major strategic investment in a West-East Link Pipeline. This is an example of water supply infrastructure resilience investment that builds in adaptation to the potential future impacts of climate change.

Case study Box 1: UUW West-East Link Pipeline

Background

United Utilities Water is constructing a 55km strategic pipeline to link its Prescot water treatment works near Liverpool to its Woodgate Hill reservoir in Bury (Greater Manchester). The pipeline will be bi-directional with a capacity of 100 million litres a day. Construction of this £125m pipeline began in spring 2009 and is expected to be completed by summer 2011.

There are multiple strategic drivers for this major investment that will further increase the flexibility and resilience of the North West's water supplies. These include:

- EU environmental legislation, which is likely to reduce the future water resources available to the company.
- The potential impact of future climate change on water source reliability.
- Risk to security of supply from planned and unplanned outages of strategic supply assets (including outages due to flooding of supply assets).

Climate change considerations

To incorporate the impacts of climate change in the cost-benefit analysis, United Utilities Water used the UK Climate Projections UKCP02 scenarios, however the CP09 scenarios also support this. The forecast impact of climate change on water resources suggested a need for a pipeline with a capacity of 60 million litres per day. However, in response to the security of supply driver, the pipeline is being built with a capacity of 100 million litres per day.

Regulatory and planning framework

In UUW's view, a scheme was unlikely to have been funded through the regulatory price review process if it had been purely driven by climate change risk considerations. Funding was due to the successful combination of the climate change risk with more certain drivers, such as the EU legislation and the supply security risks from unplanned failures of strategic supply assets. The regulatory framework provided challenging but not insurmountable barriers, requiring UUW to demonstrate a positive cost-benefit alongside sound economic and practical rationale.

Figure indicating the location of the West –East Link main within the United Utilities Water Integrated Resource Zone (IRZ).

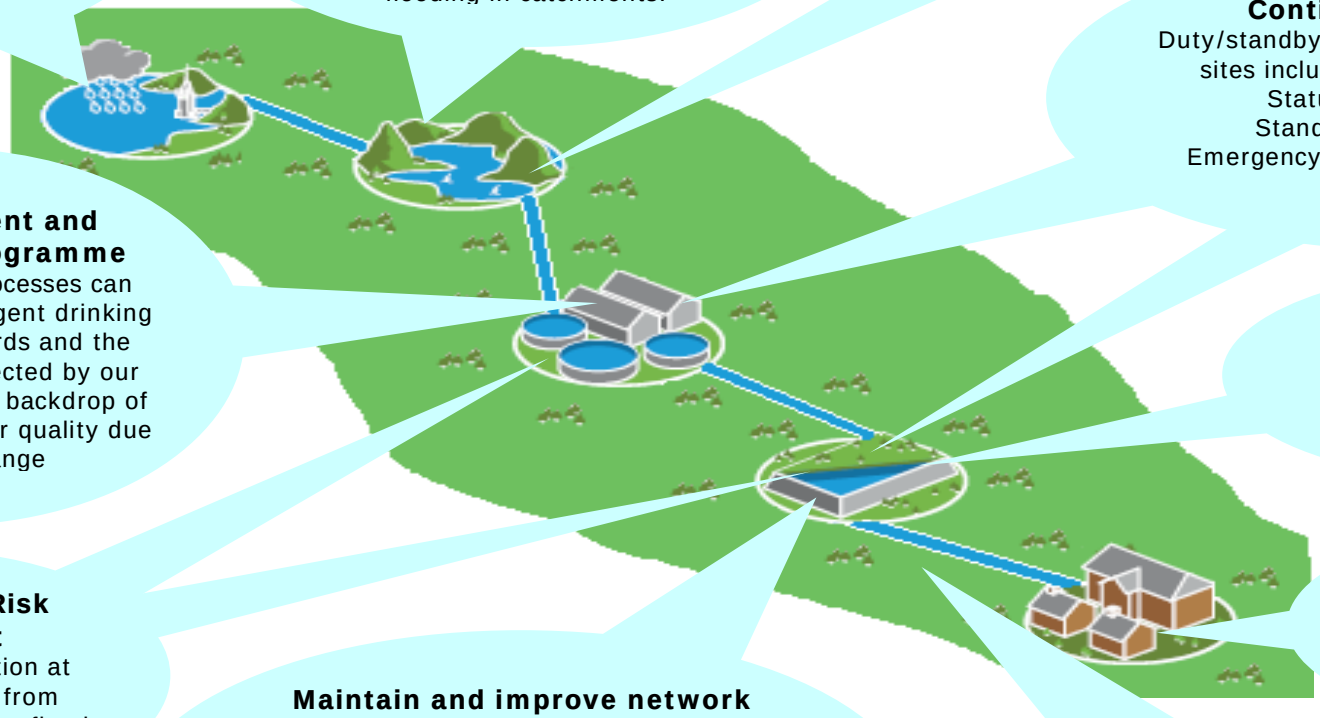
Figure 5

Current climate change adaptation activities in the water service “source to tap” supply chain

New source development
Modelling and analysis undertaken in WRMP to determine if new sources are required, e.g. South Egremont borehole scheme in West Cumbria.

Catchment Management Activities
Land use and ecological management to prevent deterioration of raw water quality, manage hydrological response to rainfall and help alleviate flooding in catchments.

Reservoir Safety
10 yearly statutory inspections, 6 monthly supervising engineer inspections and proactive maintenance programme.
Spillway capacities designed and refurbished to withstand a Probable Maximum Flood.
Climate change impact studies.



Contingency Planning
Duty/standby arrangements for all critical sites including back up generators.
Statutory Drought Plan.
Standby drought sources.
Emergency plans & plant to maintain supplies.

WTW investment and maintenance programme
Ensure treatment processes can continue to meet stringent drinking water quality standards and the aesthetic quality expected by our customers against the backdrop of deteriorating raw water quality due to climate change

Leakage Strategy
Reduce leakage to economic level as an integral part of demand management to maintain supply reliability

Facility Flood Risk Assessment
Deliver flood protection at critical sites at risk from flooding in 1:1000 year flood event

Demand management activities
Water efficiency programme and education

Maintain and improve network resilience
Existing supply system designed for peak demand greater than the forecast increase in peak demand due to climate change.
Investment in strategic pipelines to provide greater security of supply during droughts or flooding of supply assets.

Large Diameter Trunk Main (LDTM) investment and maintenance
Ensures integrated supply system provides high degree of supply resilience against extreme weather events
New West-East Link LDTM

3.3.2 FLOOD RISK ASSESMENTS AND RESERVOIR SAFETY

UUW has assessed the impact of severe flood events on its water supply assets and the potential impact on water supply provision to customers. The assessment methodology aligns to that set out in Ofwat's 2009 guidance on flood risk assessment[20]. The analysis indicated 185 facilities were 'at risk' from a 1:1000 year flood event. However, due to the flexibility of UUW's integrated supply network, our water network modelling determined that supplies from a significant number of these facilities could be supported by bringing in water from other sources in the event of an outage caused by flooding.

For 45 facilities where alternative supplies were not available or were insufficient to fully meet customer demand, a cost-benefit assessment was completed taking into account the numbers of customers that would experience a loss of supply for more than 6 hours. From this, UUW identified three critical sites for flood protection measures to be completed during the period 2010-15 at a cost of approximately £1.6m. This investment at these three sites, in conjunction with the increased supply resilience provided by the new West East Link Main, will provide security of supply during a 1:1000 flood event to 2.1 million customers. By adopting a 1:1000 flood protection standard, we have provided resilience against the potential for climate change to increase the frequency of severe flood events.

Mitigation plans exist for the other sites where flooding could lead to a temporary loss of supply but where investment in flood protection is not justified on cost-benefit grounds due to the low number of customers affected. These mitigation plans include deployment of alternative supplies, including tankers to pump water into the supply network and bottled water deliveries. We also work with our asset insurers to review flood mitigation measures at our sites, for example raising the level of critical electrical or control assets above extreme flood height levels to help minimise damage and enable a faster post-flood operational recovery.

We will continue to review the latest evidence of the effects of climate change on flood risk for unprotected sites. If the frequency of severe floods was predicted to significantly increase above current projections, this may lead to flood protection measures becoming justified in the future.

Case study Box 2 outlines the flood defence work we have undertaken at one of our Water Treatment Works.

UUW's reservoir safety programme ensures all of our dams can withstand very extreme rainfall events, 1:10,000 or higher, through statutory inspections, flood studies, embankment condition investigations and substantial maintenance programmes. Statutory 10-yearly Inspecting Engineer inspections and 6-monthly Supervising Engineer inspections are undertaken at all of our dams to assess whether any safety improvements are required. All of our reservoir spillways are designed and refurbished to withstand the Probable Maximum Flood (PMF) in accordance with national reservoir safety standards. UUW is carrying out climate change risk studies over the next five years to assess whether any additional measures may be needed for dams in the future. For example, if more extreme

[20] Halcrow (2008) Asset resilience to flood hazards: Development of an analytical framework http://www.ofwat.gov.uk/pricereview/ltr_pr0912_resilfloodhazglos.pdf

weather patterns occur, this could result in an increased magnitude of reservoir water level fluctuations with potential adverse impacts on earth embankments.

Case study Box 2: Flood Defence work at Huntington WTW

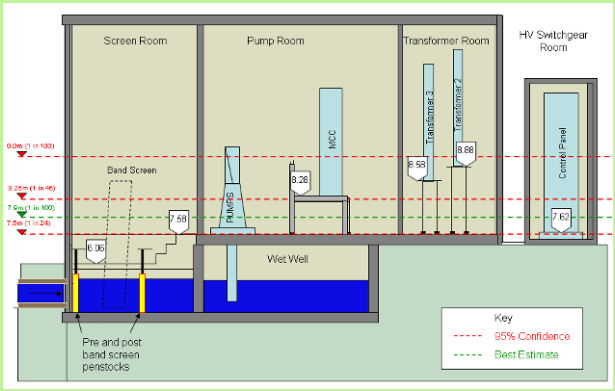
Background

Huntington WTW is a key treatment works in the UUW water supply system, contributing up to one fifth of the total regional water production. The works treats water taken from the River Dee via an intake pumping station.

The consequence of loss of this supply is that alternative supplies must be made available requiring significant additional operational effort in the short term. Without the supply from Huntington being available, the system is not sustainable and after a few days supplies to customers are at risk.

Flood risk

In November 2000 there was widespread flooding on the River Dee. The river level reached the door step of the intake pumping station. Sand bags were used to try to keep the flood waters back but with limited success. Operational contingency plans were put in place but in the event did not need to be implemented.



If the flood waters had risen further they could have damaged the electrical and control equipment for the pumping station. It was estimated that the time needed to carry out repairs, or to install temporary pumps and power generation, would be longer than the system could tolerate before supplies to customers were lost.

Climate change considerations

The flood of 2000 was similar to that which occurred in 1965. A study was commissioned which assessed the return period to be one in 15 years. Taking into account the predicted effects of climate change i.e. increasing frequency and severity of floods, it was decided to protect the pumping station from a one in 100 year flood at 95% confidence. This is considered to be an appropriate balance between the costs of protecting the pumping station and the risk of loss of supply.

Project scope

Various options were considered for protection of the pumping station. The selected scheme involved construction of a 125m long, 2.5m high earthwork bund, four large penstocks to control flows during floods and a balancing tank to allow screen washing waste to be collected and allow the pumping station to continue to operate. Ancillary works included relocating a pollution monitoring station to inside the bund and removing the old one.

The work was started in mid-2006 and completed in June 2007 at a cost £2m.

Figures show the flood levels and flood defence bund at Huntington

3.3.3 WATER TREATMENT, WATER QUALITY AND CATCHMENT MANAGEMENT

In addition to the water resources and flooding impacts related to climate change, it is anticipated that there will be adverse effects on raw water quality in reservoirs and rivers. This may impact on water treatment processes and increase the risk of non-compliance with drinking water standards. This issue is unique to raw water sources in upland areas therefore UU is one of few water companies that face this problem.

The conventional solution is to upgrade the treatment process at high cost. UUW has adopted a more sustainable solution to work in partnership with stakeholders to manage the catchment. UUW currently manages water quality risks within raw water catchments through its Sustainable Catchment Management Programme (SCaMP) for UU owned catchments (see Case study Box 3). We have an improvement programme for non UU owned catchments in partnership with a wide range of stakeholders such as Lake District National Park Authority, Natural England, Defra and Moors for the Future (see Case Study Box 4). In addition we We have Drinking Water Safety Plans (DWSP), maintenance and management of treatment processes, raw water quality monitoring and continued WTW investment help ensure that drinking water quality standards can be met despite deterioration in raw water quality.

Climate change may require increased investment in both catchment management activities (such as SCaMP) and in more complex treatment processes to ensure drinking water quality standards continue to be met. To help assess this risk, our current SCaMP programme includes monitoring and analysis to help derive causal relationships between land/soil conditions and raw water quality.

We have also contributed to UKWIR[21] research to assess the potential effects of climate change on the bio-chemical quality of reservoirs, lakes and rivers. For example, higher temperatures could lead to an increased incidence of algae in raw water, with implications for filtration processes at water treatment works (reduced throughput) as well as adverse taste and odour impacts on treated water at the customer's tap.

It is also possible, should we receive higher temperatures, that there will be an increase in microbial growth in water pipes and service reservoirs within the supply network. To combat this we will need to continue to closely monitor and review chlorine residual requirements throughout the WTW to tap supply system.

[21] UKWIR (2007) Effect of Climate Change on River Water Quality

Case study Box 3: United Utilities Water Sustainable Catchment Management Programme (SCaMP)

Background

The objective of the United Utilities Water SCaMP programme is to develop an integrated approach to catchment management which delivers, improved raw water quality and supports priority Biodiversity Action Plan habitats and species at risk due climate change.

Between 2005 and 2010, our inaugural SCaMP programme invested £10m on UUW water catchment land, improving the condition of 12,322 hectares of blanket bog within Sites of Special Scientific Interest and 273 hectares of new native broadleaved woodland were created. Our 2010-15 SCAMP2 programme includes a further 3,000 hectares of moorland restoration and tree planting is anticipated to take place across 1426 hectares of water catchment land.

Climate change benefits

Rewetting and revegetating the moors will improve the ability of the moors to store carbon and function as a more active blanket bog habitat resulting in:-

- Reduced rate of soil erosion (turbidity) and lower dissolved organic carbon concentrations in streams and reservoirs, improving raw water quality during high rainfall events
- Increased moisture retention, reducing the risk of dessication of upland peat soils and moorland fires in dry weather conditions which can lead to higher turbidity and water colour in raw water supplies when heavy rainfall events subsequently occur.
- Improved soil water storage, helping to attenuate runoff following heavy rainfall events and thereby reducing downstream flood risks

Woodland and scrubland creation concentrated in high risk erosion areas will reduce the risks of landslips, reducing the risk of extremely high turbidity levels in raw water supplies. The improved vegetation cover will also act as a potential carbon sink.

The pictures above indicate the restoration that has taken place at Quiet Shepherd, Longdendale Valleyin the Peak District (left in 2007 and right 2009).

Case study Box 4: United Utilities Water improvements on catchment land not owned by United Utilities

Background

United Utilities are working with partners to improve two catchments, Woodhead and Kinder from 2010 to 2015 using techniques successfully tried and tested on the SCaMP programme. The aim of these Catchment Improvement Programmes is to restore significant areas of eroded moorland to improve raw water quality in Woodhead and Kinder reservoirs and at the inlets to Arnfield and Wybersley WTWs.

The Woodhead catchment programme is being matched financially by Natural England through agri-environment funding and EU Life + funding and also involves working closely with the private land owner.

The Kinder catchment programme is matched financially by Natural England and the National Trust who own the land. Kinder Reservoir catchment is part of the damaged Kinder Plateau of which 22% is bare and eroding peat.

These programmes involves very significant works at a landscape scale across the Woodhead and Kinder catchments and will deliver multiple benefits including: -

- Improving raw water quality in the future, reducing organic and particulate concentrations from the raw water and providing a reduced challenge on the WTW.
- Enhancing biodiversity and delivering UK Biodiversity Action Plan (BAP) targets.
- Securing, stabilising and potentially enhancing the significant carbon stores within the peat soil on the catchment.
- Protecting and enhancing upland landscapes.
- Improving soil stability and reduce the loss of nutrients into water bodies.

Climate change benefits

Rewetting and revegetating the moors increases the ability of the fragile habitats to withstand climate change improving the ability of the moors to store carbon and function as a more active blanket bog habitat resulting in:-

- Reduced rate of soil erosion (turbidity) and lower dissolved organic carbon concentrations in streams and reservoirs, improving raw water quality during high rainfall events;
- Increased moisture retention, reducing the risk of dessication of upland peat soils and moorland fires in dry weather conditions which can lead to higher turbidity and water colour in raw water supplies when heavy rainfall events subsequently occur.
- Improved soil water storage, helping to attenuate runoff following heavy rainfall events and thereby reducing downstream flood risks

The picture shows Woodhead Estate East of Bleaklow Head, possibly the most degraded upland peat in Europe and it is in a National Park

Pictures showing a variety of gully blocking techniques at Kinder catchment where around 1,800 dams are being installed to raise the water table, encourage peat sedimentation & revegetation

3.4 CURRENT ADAPTATION IN OUR WASTEWATER BUSINESS

In comparison with our water service, our wastewater service has considered climate change in our business planning and strategy to a lesser extent. In both service areas climate change presents a risk of service failure. One of the main reasons for this difference in approach is the difference in the potential consequences of service failure.

Currently we do not routinely upsize our wastewater assets to take account of climate change. The reason for this is twofold. Firstly, we believe that it is unsustainable to upsize assets to accommodate changes in storm intensity or frequency. Secondly, the climate change scenarios are too uncertain to support any potential benefit of such investment in increasing the capacity of the assets. We are, therefore, developing a more sustainable approach to the management of surface water. At present, we are working closely in partnership with our stakeholders to find ways of achieving this. One example is our work with the EA and Local Authorities on Surface Water Management Plans (see Case study Box 5). Another example is our work with Ofwat on their Sustainable Drainage Project[22]. Figure 6 below compares two different solutions to storm water management. On the left is a conventional 'hard-engineered' solution. On the right is a Sustainable Drainage System, or 'SUD'.

Figure 6: A traditional versus a sustainable solution to storm water management

Storm water detention tanks in an urban area.

Storm water detention pond in a housing development.

[22] http://www.ofwat.gov.uk/future/sustainable/drainage

Case study Box 5: Surface water management work

Introduction

United Utilities Water has been aware for a number of years of the need to manage surface water in a more sustainable manner. Such activity will assist in resolving the current need to implement more sustainable/integrated solutions here and now and set the foundations for more fundamental changes that will be required in the longer term to adapt to climate change.

Our work stream has three key aspects :-

- Legislation and regulation
- Our approach to collaborative working with Local Authorities (LAs) and the EA
- Changing behaviours

Legislation and regulation

We have been working with Defra and other Government departments since the severe flooding in 2007 to ensure that the need for legislation is recognised and that appropriate legislation is produced and enacted, for example the Floods and Water Management Act 2010, National SUDS standards.

Our approach to collaborative working with LAs and the EA

Data sharing

We have recognised the need to fundamentally change the way the we work with these key stakeholders and the new duties contained in the Floods and Water Management Act and the Flood Risk regulations has further highlighted this need.

In 2009 (ahead of any legislative requirement), UUW made a major change in its policy on data sharing with LAs. This moved us from a conservative position to a voluntarily open stance, whereby we now share free of charge the following information:-

- UUW Drainage Areas
- DG5 “At risk register” (Internal & External)
- Results from our hydraulic model runs
- Metadata for the hydraulic models
- Extracts from our sewerage incident database
- Asset data
- Expertise and advice on above data and drainage matters

The current policy is now being extended to cover all Lead Local Flood Authorities rather than just those producing SWMPs.

Partnerships

The partnerships originally developed for producing SWMPs are also being further enhanced.

UUW has worked with AGMA (Association of Greater Manchester Authorities) to assess the

existing capacity of the 10 LAs across Greater Manchester to comply with their new responsibilities and to develop innovative new approaches to the management of flood risk at a city region level.

We are also working with the EA to develop a Memorandum Of Understanding that will enhance existing joint working practices on flood risk management specifically data sharing, relationships with LAs and incident management.

Changing behaviours

We have changed the way in which we charge our measured non household customers for dealing with their surface water.

We now charge for surface water on a site area basis where the larger the area draining to the public sewer, the higher the charge. Conversely, where there is no area draining to the public sewer, the charge is zero. There is also a reduction of 50% where green roofs are fitted.

The underling driver is to change behaviours regarding how people manage their surface water by providing an incentive for choosing the more sustainable option.

3.4.1 SUSTAINABLE DRAINAGE SYSTEMS

Climate change adaptation in our wastewater business is centred on the sustainability of 'urban' drainage systems. Urban drainage systems collect the rainwater and wastewater from urban areas and send it via the sewerage system to wastewater treatment works for safe return to the environment. Many existing urban drainage systems experience problems of flooding, pollution or damage to the environment and are not proving to be sustainable. Rural drainage systems include septic tanks and small wastewater treatment works which serve small groups of properties in rural settings. The predicted impact of climate change, specifically changing rainfall patterns, will be less significant for rural drainage systems owing to their scale and relative isolation. In contrast, urban drainage systems are interconnected and the impact of changing rainfall patterns will be magnified.

Sustainable drainage is a concept that includes long term environmental and social factors in decisions about drainage. It takes account of the quantity and quality of runoff, and the amenity value of surface water in the urban environment[23]. These systems are more sustainable than conventional drainage methods because they:

- Collect surface water runoff close to where the rain falls to slow the rate of water runoff in heavily urbanised areas and reduce flash flooding
- Protect or enhance water quality by managing pollution at source
- Provide a habitat for wildlife
- Are appropriate to the local environment and needs of the community

Due to uncertainty regarding the impact of climate change, no investment is specifically included in our business plan for 2010 to 2015 to accommodate changes in storm intensity or frequency. This is an area we will keep under review especially in light of the ongoing national research. We will be

[23] CIRIA (2005) SUDS http://www.ciria.com/suds/background.htm

undertaking a Sustainable Drainage Systems (SUDS) demonstration project during 2010-15 to support the implementation of retrofitted SUDS in the longer term.

Defra has issued guidance in this area which is outlined in the document Flood and Coastal Defence Appraisal[24]. This guidance recommends using a 20% uplift, to design criteria for storms, to a 70 year planning horizon (up to 2080). In developing our Wastewater Supply Demand Management Plan we applied a 5% (from 1990 to 2025) uplift in storm intensity to assess the impact of changes in rainfall arising from climate change. This was only used to identify the marginal additional cost to projects to deal with such an increase in storm flows and not included in the Final Business Plan for the period 2010-2015.

By implementing demand side solutions such as Integrated Urban Drainage (IUD) and other adaptation techniques by 2035, it is our intention to significantly reduce the impact of such changes in storm intensity. In accordance with our Strategic Direction Statement it is our view that it is unsustainable for the Water Industry to continually upsize assets to accommodate increased flows resulting from increased rainfall. The current uncertainty regarding the impact of climate change combined with our strategic approach to utilise demand management, has led us to take a reasoned decision not to include any generic uplift to our design criteria solely for increases in storm intensity due to climate change. This policy is in line with our interpretation of Ofwat's 2008[25] guidance and we consider it offers best value to our customers (and indeed our plans to mitigate the carbon footprint of our operations).

Changes in rainfall patterns due to climate change will vary spatially across our region. Therefore, investment needs will be implemented through our Integrated Asset Planning process (see Figure 3) to ensure that holistic and sustainable solutions are progressed. A risk-based methodology has been applied to our wastewater system over the 25 year planning period. This identified 'at risk' Wastewater Treatment Works and categorised network drainage areas according to their relative exposure to demand-led impacts, including climate change.

The uncertainties associated with climate change reinforce the requirement for our Wastewater Supply Demand Management Plan to be flexible and adaptable so that we can respond to issues as they arise or as clarification on them is obtained. As part of our Integrated Asset Planning approach we will keep our plan under review to ensure that it continues to adapt to changing circumstances and better information.

3.4.2 MODELLING AND MONITORING

We have included a project in our 2010-15 investment programme to enhance our network modelling coverage and monitoring capacity. This will allow us to better understand the detailed impact of development with the aim of influencing developers and planning authorities to prevent any service deterioration. This project will provide the following benefits for our customers to:

- assist in the implementation of mitigation measures, the assessment of the impact of climate change, and will be key to the development of Surface Water Management Plans (SWMPs) – see Case study Box 5.

[24] Defra (2006), Flood and Coastal Defence Appraisal Guidance, FCDPAG3 Economic Appraisal, Supplementary Note to Operating Authorities – Climate Change Impact.

[25] Ofwat (2008) PR09/13 Sewerage System Design and Climate Change.

- provide a detailed understanding of surface flows which will help us to manage our sewer network based on the principles of IUD
- provide further detail and regional coverage of information to enhance our understanding of the impacts of changes to demand
- support our work with the local authorities to ensure that when development takes place, its impact on our assets is minimised, including influencing the points of connection to the sewer network.

The predicted impact of warmer temperatures and changing rainfall patterns on water quality is not yet fully understood. To consider the potential adaptation required for wastewater treatment we are working with the EA to develop SIMCAT models. The outcomes will inform investment plans for future water quality improvements. This is in line with our obligations under the Water Framework Directive (2000)[26] and is consistent with our Integrated Asset Planning process. The SIMCAT modelled scenarios are used to develop solutions to meet water quality requirements in the most sustainable way. This work is being carried out in parallel to our own Integrated Catchment Modelling (ICM) work in order to understand the impact of tighter discharge consents.

We are also using modelling for climate change adaptation work in regards flood risk data. We are sharing our hydraulic modelling data with the EA and LAs to develop joint flood risk maps for our work on Surface Water Management, as outlined in Case study Box 5.

[26] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000L0060:EN:NOT

3.5 CURRENT ADAPTATION IN OUR SUPPORT SERVICES

UUW's business support services comprise Information Technology (IT), Human Resources (HR), Supply Chain, Legal, Finance, Communications and Property services. Our current approach to adapting these services to the impacts of climate change is undertaken as part of resilience or 'business continuity' planning. As well as a strategic approach, work has also been driven by experience from extreme events (see Table 1).

3.5.1 INFORMATION TECHNOLOGY

Our strategy has been to centralise all IT and data systems into two data centres. Within the next three years we will be switching to one primary data centre and a backup data centre. Therefore, in the event of the loss of the primary data centre owing to the impacts of climate change or other business threat, the critical IT systems will be available from the backup data centre. Furthermore, the mechanical and electrical installations at the primary data centre are being designed for greater resilience.

The data centres enable UUW staff to access IT systems and data from any site connected to the corporate data network. Therefore, in the event of access to a site being prevented by climate impacts or other event, staff are able to relocate to an alternative site and access their systems in the usual way. This work has been driven by efficiency needs and the need to secure corporate data, as well as provide flexibility for systems and data to be accessed from any site.

The data systems can also be accessed remotely, enabling access from any device from any location via a secure, password-protected internet portal. During the cold weather event in January 2010 this system became overwhelmed by the number of staff attempting to gain remote access because transport to places of work was disrupted. This was remedied immediately and the number of licences enabling remote access was increased to be capable of supporting all staff using a remote device.

There are 14 sites that are deemed critical regarding IT services, comprising our head office, 4 Water Treatment Works and 9 Wastewater Treatment Works. These sites are part of a current IT transformation project which will provide a new telephony solution and a resilient wide area connection to the sites from the central data centres. This investment is primarily driven by the need to replace out-dated telephony infrastructure and provide a more efficient communications system. However, there are further benefits in terms of adapting to the impacts of climate-related events. The new telephony solution has more resilience because it has fewer single points of failure. For instance, sites will be supported by two network links from the central data centre, so that if one fails the other provides a backup communications link. Furthermore, these links are not reliant on the internet, they are fixed network communications dedicated to UUW.

3.5.2 SUPPLY CHAIN

Our arrangements with suppliers are based on short-term contracts, lasting for a period of five years at the most. This approach allows us to be flexible in terms of efficiently meeting the current business needs and getting best value for money. This approach also offers a means of adapting to changes in climate. As the impacts of climate change are realised overtime, we can seek alternative suppliers where an existing product or service is no longer "fit for purpose".

We are currently working with our suppliers on a UUW initiative called "Sustainable Supply Chain" primarily driven by the need to ensure business continuity and put in place resilience measures to deal with any event (climate

related or otherwise) that may impact the supply chain and ultimately our ability to provide water and wastewater services. This initiative considers, for example, whether a supplier has a high water consumption. We are then able to use our industry expertise to advise on water efficiency measures.

We also work with energy suppliers to secure our future supply at the lowest cost. This is driven by the need to be efficient and ensure business continuity, however there are further benefits for climate change adaptation. We will be able to build on our relationship with our energy supplier to carry out the adaptation activities identified in Section 5 of this report regarding site specific resilience plans.

3.5.3 HUMAN RESOURCES

Many of our staff already have the flexibility to work remotely. This suits personal circumstances and provides business continuity in the case of events preventing access to usual places of work. The improvement of our IT systems will also benefit the ability of our staff to continue to work during such events.

We will look to the Department of Health, National Health Service (NHS) and public health professionals to provide recommendations to employers on adapting to the health effects of climate change and we will update our health and safety policies as appropriate.

3.5.4 PROPERTY SERVICES

Our current sites and office accommodation is “fit for purpose” in terms of climate, capacity, access and facilities. In line with increasing the capacity of our IT system to support remote working, we will be assessing our needs for office accommodation, in particular remote sites, in the future. Over the past decade UUW has sought to centralise staff at key regional sites. This policy will continue and be enabled by advances in remote communications, IT and HR. The work is primarily driven by a need to become more efficient, however, there are further benefits for increasing business resilience and adapting to climate related events.

3.5.5 COMMUNICATIONS

Both our press office and internal communications teams are experienced in managing communications during extreme weather events (see Table 1). Our customer communications teams are experienced in managing the customer impact of weather-related events as well as the impact of operational incidents. Future changes in climate will impact our business on an operational level as well as an organisational level so we will be able to respond to future changes in climate by drawing on our experience and the lessons learnt.

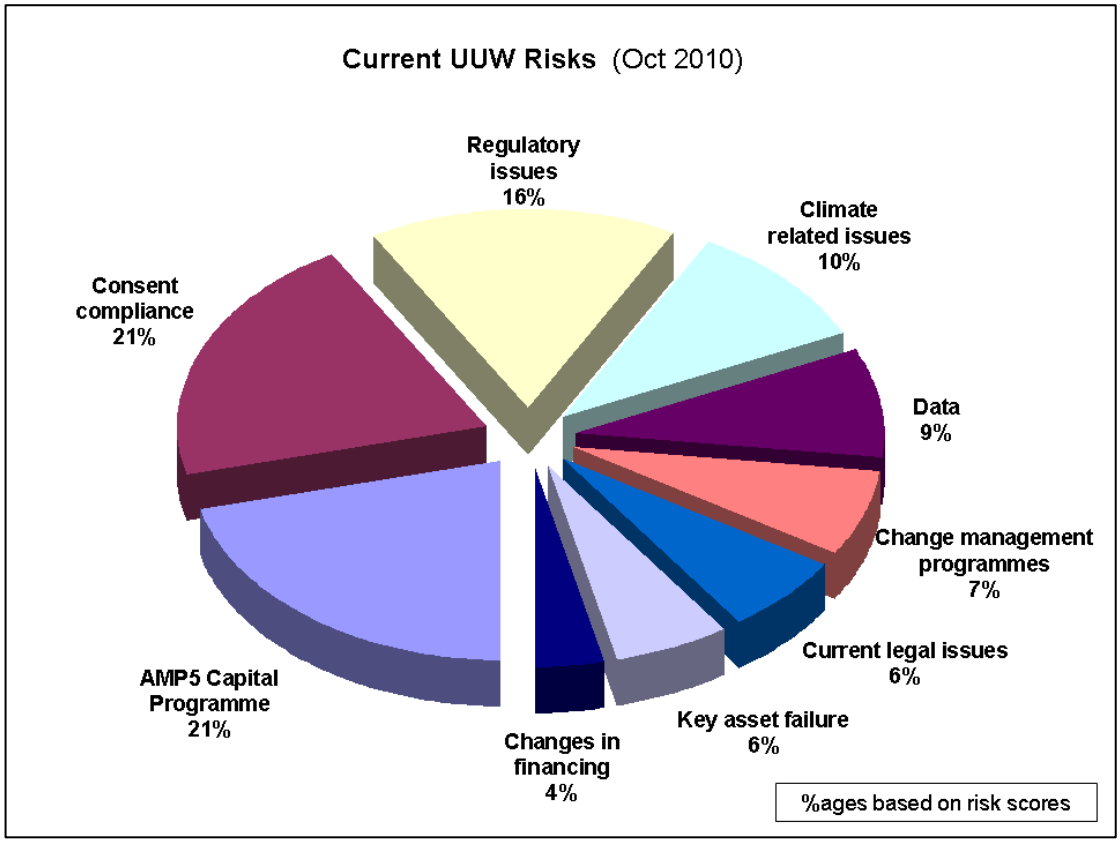
4 OUR APPROACH TO RISK ASSESSMENT

4.1 OUR STANDARD APPROACH TO RISK ASSESSMENT

UUW has a well established framework for risk management, covering all areas of the business (see Figure 7). Climate change is one of many risks to our business and is assessed in the same way as any other[27]. We have a proactive risk assessment system that is embedded into day to day business activity which provides:

- High visibility of risk
- Integration across the business
- Continuous identification and evaluation
- Proactive management of risks – opportunity, threat and uncertainty.

Figure 7: UUW current corporate risk profile



The process of assessing, evaluating and managing risk follows risk management best practice using a Severe, High, Medium and Low scale for consequence and Very Likely, Likely, Unlikely and Remote scale for likelihood. The overall risk score is calculated by multiplying the likelihood and consequence values. Risks are then prioritised according to their score. The standard matrix for risk assessment is shown in Figure 8.

[27] UUW internal document (2009), Corporate Risk Management Reference Manual and Guidelines.

Figure 8: Risk assessment matrix

Consequence	Severe	8	8	16	24	32
		7	7	14	21	28
	High	6	6	12	18	24
		5	5	10	15	20
	Medium	4	4	8	12	16
		3	3	6	9	12
	Low	2	2	4	6	8
		1	1	2	3	4
			1	2	3	4
			Remote	Unlikely	Likely	Very Likely
			Likelihood			

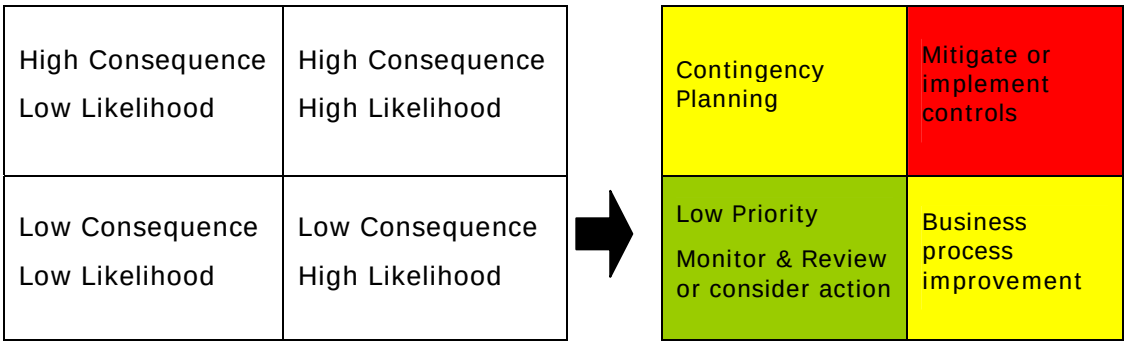
For the purpose of this report we have simplified the matrix to a four by four grid as shown in Figure 9.

Figure 9: Simplified 4 x 4 Grid of risk

Consequence	Severe	8	8	16	24	32
	High	6	6	12	18	24
	Medium	4	4	8	12	16
	Low	2	2	4	6	8
			1	2	3	4
			Remote	Unlikely	Likely	Very Likely
			Likelihood			

To assess the risk further, it can be evaluated against the four quadrants which make up the matrix (Figure 10). This indicates the relationship between impact and likelihood and the dominance of each element. This provides greater perspective than simply prioritising risk through ranking and relates directly to the type of management that should be in place or the management style that should be employed for further mitigating actions. The divides between the quadrants also act as upper limits. For example, for a risk that moves in time from a 'yellow' quadrant to the 'red' quadrant must reach a point that either increases its likelihood or increases its consequence.

Figure 10: Risk matrix evaluation quadrants

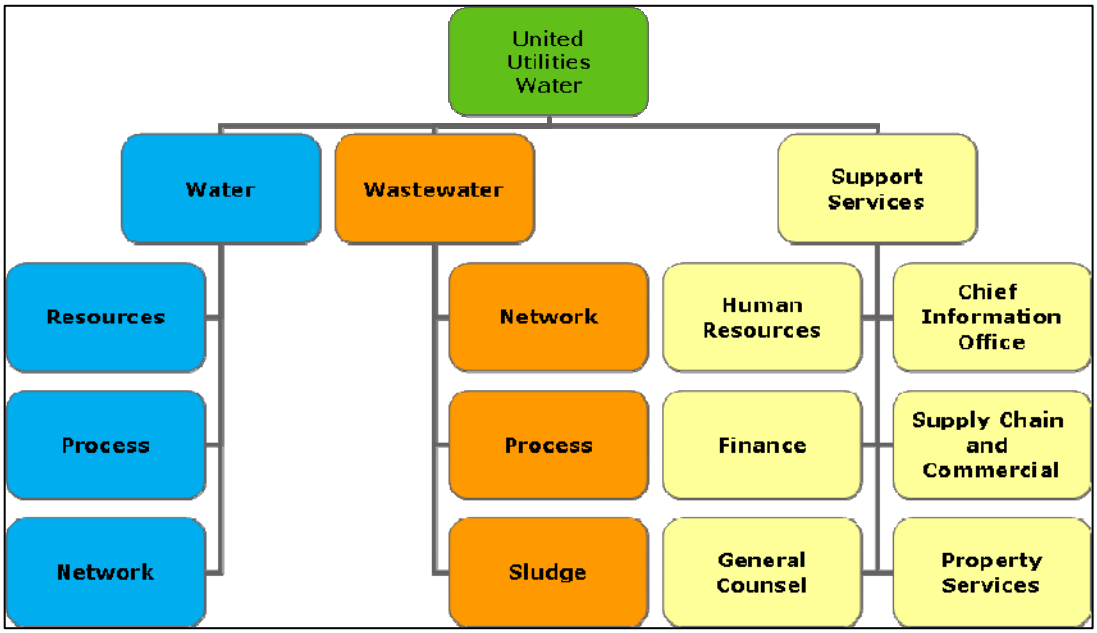


4.2 CLIMATE CHANGE RISK ASSESSMENT WORKSHOPS

The water industry, through its industry body WaterUK, has developed a methodology[28] for assessing the risks of climate change. This focuses on the asset base and provides a starting point for our own risk assessment. We followed the standard company approach to score the risks as outlined above.

We know that the impacts of climate change do not just affect the physical environment in which we operate. Climate change touches all parts of our organisation, from human resources to telecommunications. With this in mind, we have included all parts of our organisation in our risk assessment and adaptation programme. A series of workshops was held across the company to explore the climate risk in each part of the organisation (Figure 11). We worked with our own company experts to identify and evaluate potential risks according to the WaterUK methodology. The full outcome of the risk assessment workshops is included in Appendix 1.

Figure 11: Risk assessment workshops



[28] WaterUK (2007), A climate change adaptation approach for asset management planning.

In preparation for the workshops we reviewed the CP09 scenarios and made the following assumptions:

- High emissions scenario – evidence shows that current emissions are already at this level, if not above, and the failure to reach an international agreement in Copenhagen and Cancun 2010 means there is no statutory mechanism in place to cut emissions on a global scale.
- 50% probability – the central estimate has an acceptable level of uncertainty for our purposes.

We then tailored the predicted impacts according to our assumptions and presented the climate change predictions to our panel of company experts. The full set of climate change projections is included in Appendix 2. To fit the projections to our current business timeframe we have inferred the figures for 2035 from the UKCP09 data (Table 2). Although this does not provide us with an upper or lower estimate, our long-term business focus is on 25 years ahead and, therefore, we feel it is most appropriate to consider this timescale in our current climate change risk assessment. We will look beyond 2035 as we approach our next business planning cycle with the price review in 2014 (PR14). We will also update our risk assessment and climate change adaptation plan accordingly in addition to the review and monitoring outlined in Section 8.

It is important to note that our WRMP (2009)[6] (on which many of the Water Service actions are based) used the UKCIP02 scenarios and assumes a medium emissions scenario. However, we have used the CP09 scenarios for all the risk assessments in this report.

Table 2: Climate change projections for North West England (2035) used by UUW

Temperature increase	Precipitation change	Sea level change
1.65°C winter mean	0% annual mean	0.15m
2.25°C summer mean	8.5% winter mean	
2.9°C summer mean daily maximum	-11.5% summer mean	

Assuming that the current risk of climate change to our business is managed by our end-to-end business process, it is not relevant to detail this level of risk. Given the projections in Table 2, we assessed the initial level of risk at 2035, identifying any adaptation actions already being undertaken, and reassessing the risk with this in mind. In some cases this resulted in a reduced residual risk score, through a reduction in the consequence and/or likelihood. However, in many cases the initial risk score was still valid. We then proposed actions to reduce the residual risk. These proposed actions form part of our adaptation programme (see Section 5). We did not assess the impact of these proposed actions on the residual risk score because the outcomes are unknown at this time. However, we will continue to monitor and re-evaluate the risk scores as our adaptation programme progresses, in line with our business processes (Figure 3) and as detailed in Section 8.

At the workshops we also attempted to repeat the detailed risk assessment for the 2050 and 2080 time horizons. However, there are so many uncertainties associated with the climate change predictions so far into the future that the

detail of the risk would be irrelevant. We acknowledged that there would be significant changes to the climate and a therefore a need to shift our business activities accordingly. However, the point at which this occurs, or the 'threshold', will not be in the short or medium term business planning horizon. This supports one of our main assumptions, which is that climate change in the North West region will continue to be a relatively gradual change rather than materialise in a catastrophic step-change event.

In order to investigate thresholds and sensitivities of our water and wastewater treatment processes to climate change we are involved in two UKWIR research projects[29] [30]. This work will look at the potential impacts on existing treatment processes and identify generic sensitivities and thresholds where climate change could have an impact, both positive and negative. It will also seek to identify potential adaptive options. The outcome of this work will feed into our adaptation programme.

4.3 OUTCOME OF THE RISK ASSESSMENT

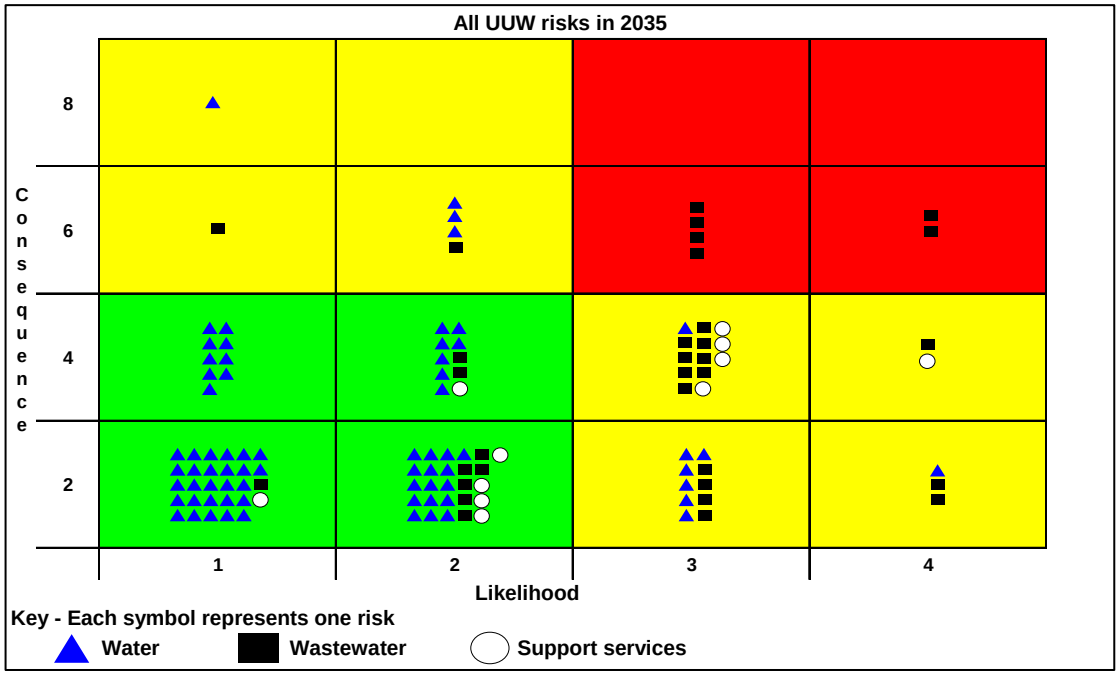
Once the risk assessments had been undertaken by our groups of experts, the scores were normalised by a sub-group to ensure consistency. The initial risk score was plotted on a risk matrix (see Figures 13 to 19). Following consideration of the adaptation actions currently being undertaken the risk score was reassessed and an arrow added to the matrix to indicate the new risk score and where it now features on the risk matrix. These figures provide a high-level view of where the climate change risks are in the risk matrix for each of our three main business sectors (water, wastewater and support services). Each of the risks assessed in the workshops have a unique reference number so they can be traced back to the original assessment spreadsheets in Appendix 1.

If the risk remained in the red quadrant or yellow quadrants, following re-assessment, then the risk was considered a priority. These priority risks are presented in Tables 3 to 8 with details of: the risk, any current adaptation activity being undertaken, the proposed action to reduce the residual risk along with outline costs and timescales.

Figure 12 shows a summary of the results from all the workshops and shows the overall spread of risk across the 3 business sectors.

[29] UKWIR CL08 Water Treatment and Climate Change
[30] UKWIR CL12 Wastewater Treatment and Climate Change

Figure 12: Summary of all UUW climate change risks



The full risk assessment for the water and wastewater business and support services is provided in Appendix 1. The risks assessed have been split into seven areas:

- Water Resources
- Water Treatment
- Water Network
- Wastewater Network
- Wastewater Treatment
- Wastewater Sludge
- Support services

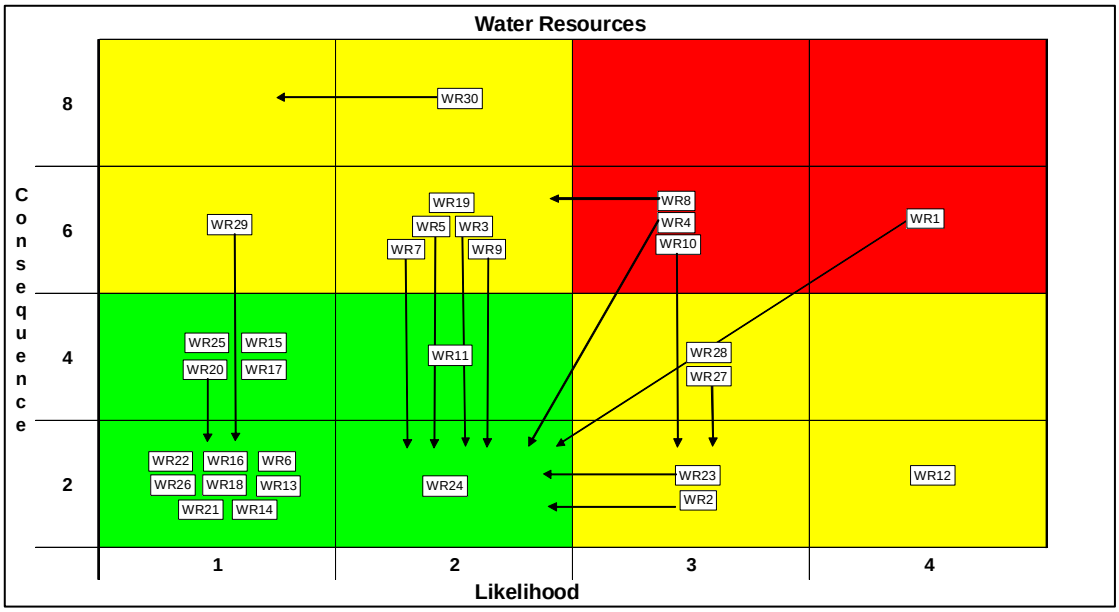
Under each of these areas a risk matrix is presented, plotting the initial risk scores as identified at the workshops. The highest priority risks are those in the red quadrant. They are summarised in the table below the relevant matrix. The table also identified any current adaptation activity and shows whether or not this reduces the risk score. Risks with a reduced score are indicated on the matrix by an arrow showing the movement from initial to residual score.

It is clear that, particularly for the water service, the current adaption activities reduce the level of risk from climate change. Many of these activities have long-standing statutory requirements which ensure that the work is undertaken, and indeed, has been undertaken for many years. Furthermore, the associated investment plans have been funded through the regulatory price review process.

In contrast, the Wastewater figures highlight that little work has been completed to date that effectively reduces the risk score. There has been no statutory requirement to include climate change in our business planning for the Wastewater Service. However, adaptation plans are developing in this area. We recognise that we will need to work in partnership with other organisations and be innovative in order to manage the risk of climate change to our business.

4.3.1 WATER

Figure 13: Water Resources risk matrix

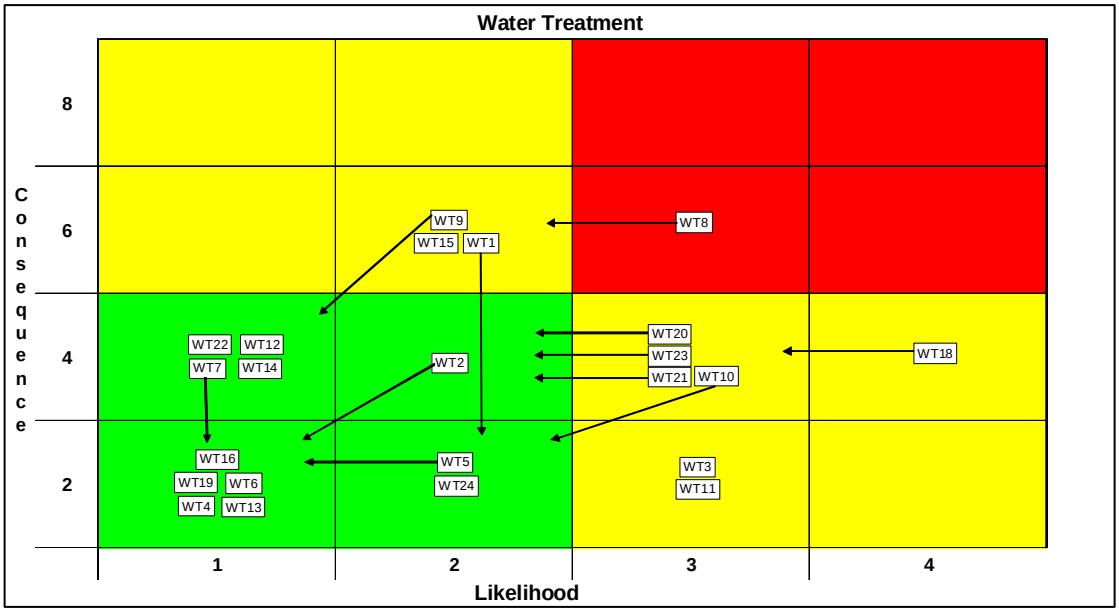


The four priority risks (shown in the red quadrant) in Figure 13 are listed in Table 3 below with a summary of the impact and consequences, and current adaptation activity.

Table 3: Water Resources priority risks and adaptation activities

Risk ref	Impact and consequence	Initial risk score (2035)	Current adaptation activity	Residual risk score (2035)
WR1	Drought reduces available water supply and reduces security of supply	24	Water Resource Management Plan, Drought Plan, Integrated Resource Zone, West-East link pipeline.	4
WR8	Flooding of assets resulting in loss of operation of critical sites	18	Flood risk study as part of price review process. Work in 2010-2015 to protect high risk assets against current 1:1000 year event	12
WR4	Lower river and borehole yields, increasing demand on existing storage and reducing security of supply	18	Water Resource Management Plan, Drought Plan, Integrated Resource Zone, West-East link pipeline.	4
WR10	Flooding leading to infiltration of raw water pipelines	18	WTWs designed to deal with ingress already with raw water monitoring.	6

Figure 14: Water Treatment risk matrix

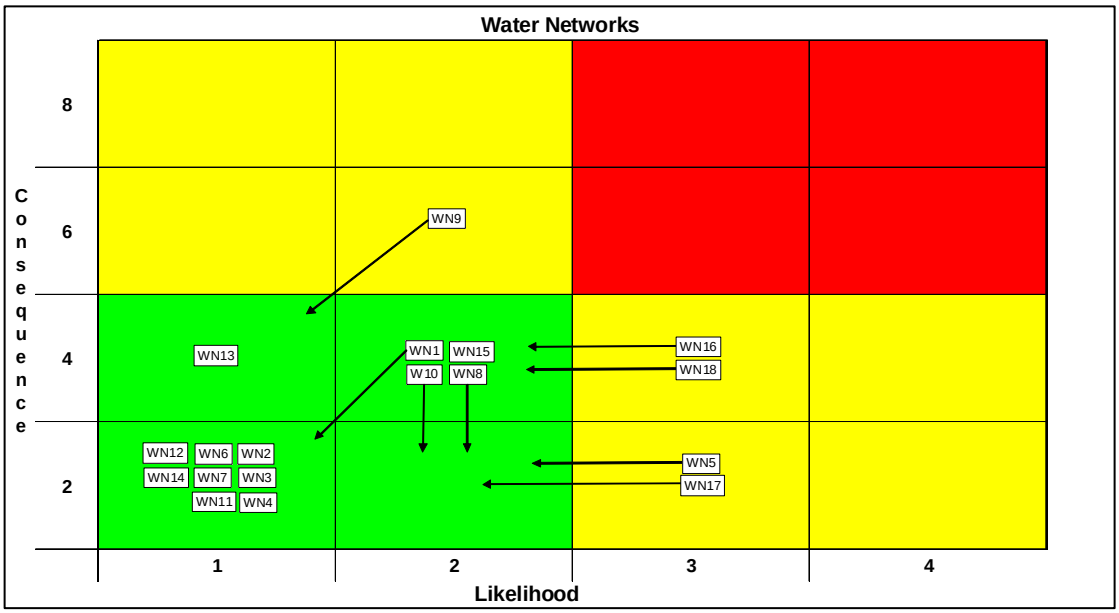


The priority risk (shown in the red quadrant) in Figure 14 is listed in Table 4 below with a summary of the impact and consequences, and current adaptation activity.

Table 4: Water Treatment priority risks and adaptation activities

Risk ref	Impact and consequence	Initial risk score (2035)	Current adaptation activity	Residual risk score (2035)
WT8	Flooding of treatment assets resulting in loss of operation	18	Flood risk study as part of price review process. Work in 2010-2015 to protect high risk assets against current 1:1000 year event	12

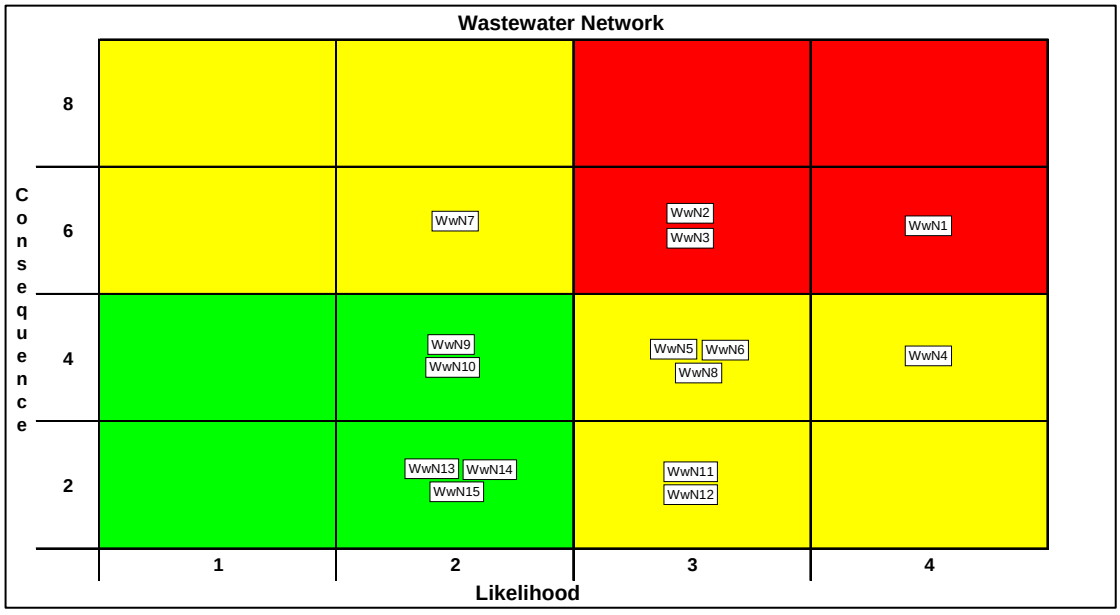
Figure 15: Water Network risk matrix



No priority risks have been identified for Water Network. A full description of the risks is given in Appendix 1.

4.3.2 WASTEWATER

Figure 16: Wastewater Network risk matrix

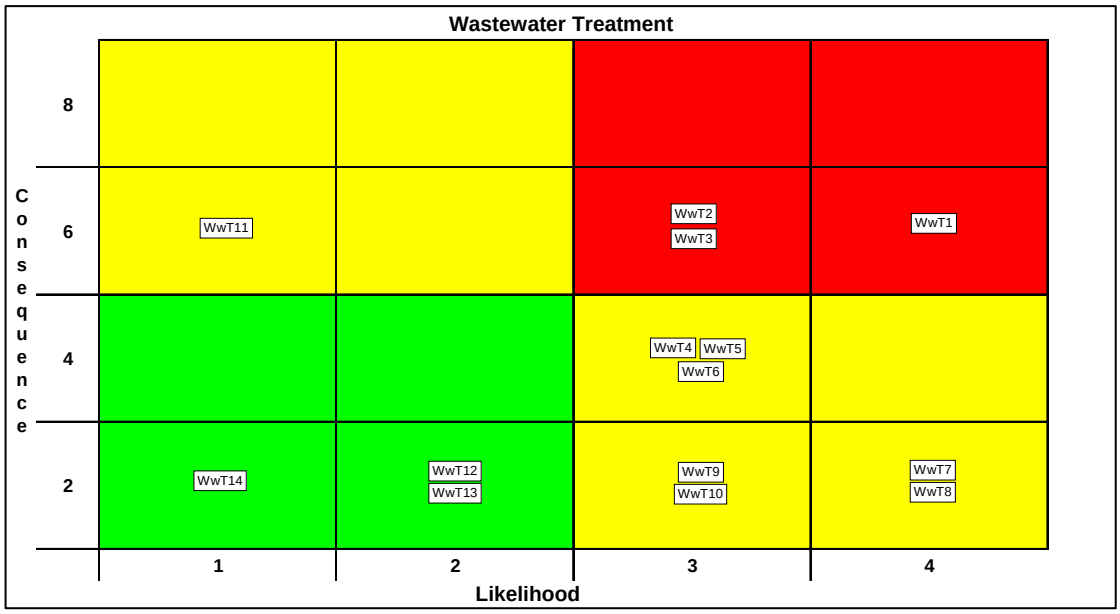


The three highest priority risks (shown in the red quadrant) in Figure 16 are listed in Table 5 below with a summary of the impact and consequences, and current adaptation activity.

Table 5: Wastewater network priority risks and current adaptation activity

Risk ref	Impact and consequence	Initial risk score (2035)	Current adaptation activity	Residual risk score (2035)
WwN1	Increased volumes of storm water exceeds sewer capacity and causes customer flooding	24	In line with our current policy we do not routinely upsize assets to take account of climate change. We are developing a more sustainable, integrated approach to managing urban drainage, however there is no visible benefit to date.	24
WWN2	Direct flooding of wastewater network assets leading to asset loss and service failure	18	Investment to date has focused on protecting Water sites.	18
WwN3	Sea level rise resulting in direct asset flooding, storm damage and coastal erosion or planned retreat leading to service failure	18	No adaptation work has been undertaken to date regarding sea level rise. The impact of this climate variable is not expected to be the most severe for the North West region, however if it happens the potential consequence will be a loss of service failure.	18

Figure 17: Wastewater Treatment risk matrix

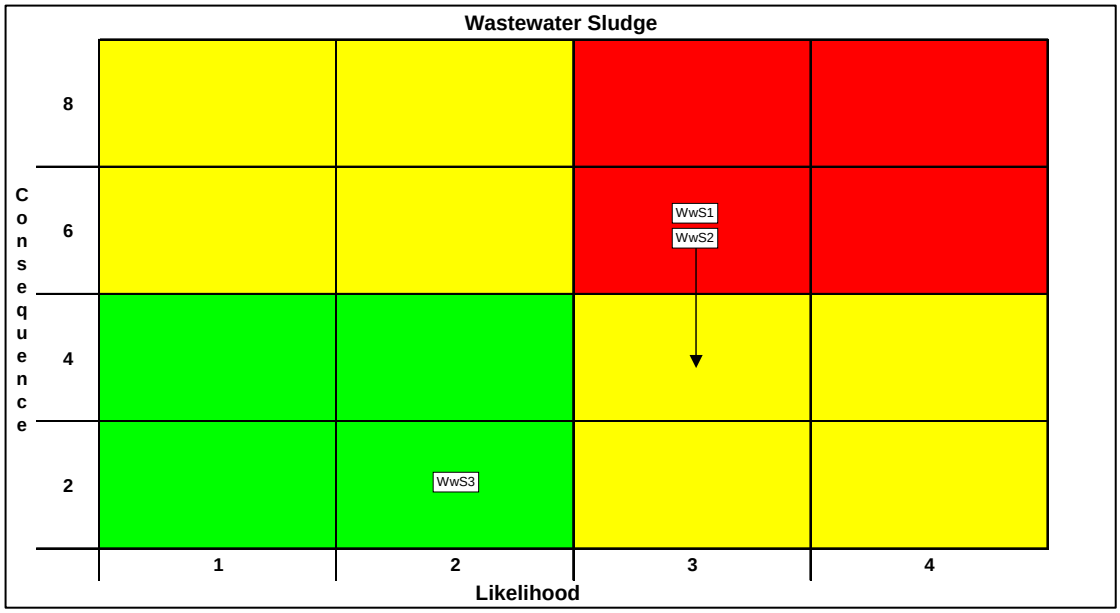


The three highest priority risks (shown in the red quadrant) in Figure 17 are listed in Table 6 below with a summary of the impact and consequences, and current adaptation activity.

Table 6: Wastewater treatment priority risks and current adaptation activity

Risk ref	Impact and consequence	Initial risk score (2035)	Current adaptation activity	Residual risk score (2035)
WwT1	Increased storm frequency causes loss of power and treatment process leading to service failure	24	No adaptation work to date has been undertaken with our power supply chain.	24
WwT2	Direct flooding of wastewater treatment assets leading to asset loss and service failure	18	Flood risk plans currently exist for PPC sites only.	18
WwT3	Reduced base flow in receiving water courses leading to tighter discharge conditions. Increased risk of consent failure and pollution.	18	Integrated Catchment Modelling (ICM) with the EA to support asset management plans. However, this is likely to support the need for tighter consents.	18

Figure 18: Wastewater Sludge risk matrix



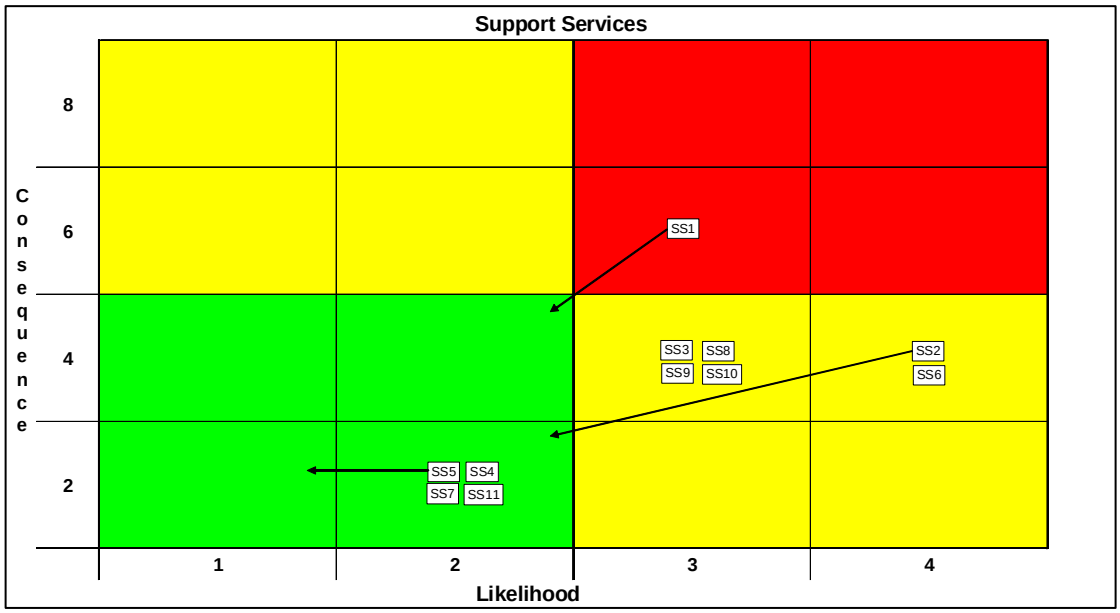
The two highest priority risks (shown in the red quadrant) in Figure 18 are listed in Table 7 below with a summary of the impact and consequences, and current adaptation activity.

Table 7: Wastewater Sludge priority risks and current adaptation activity

Risk ref	Impact and consequence	Initial risk score (2035)	Current adaptation activity	Residual risk score (2035)
WwS1	Direct flooding of sludge assets leading to asset loss and service failure	18	Flood risk plans currently exist for PPC sites only.	18
WwS2	Flooding and /or saturated ground prevents access to fields to dispose of sludge	18	Capacity of sludge incineration plant has been increased to offer alternative means of disposal	12

4.3.3 SUPPORT SERVICES

Figure 19: Support Services risk matrix



The highest priority risk (shown in the red quadrant) in Figure 19 is listed in Table 8 below with a summary of the impact and consequences, and current adaptation activity.

Table 8: Support Services priority risks and current adaptation activity

Risk ref	Impact and consequence	Initial risk score (2035)	Current adaptation activity	Residual risk score (2035)
SS1	Extreme weather impacts on communication links making telemetry/control inoperable leading to service failure	18	Work undertaken to improve the resilience and capacity of communication links	8

5 OUR ADAPTATION PLANS

5.1 WATER SERVICE

UUW's adaptation plan for its water service is provided in Table 10. These measures have been proposed to address the priority risks identified through the risk assessment workshops and are displayed in the yellow quadrants of Figures 13 to 15. A detailed description of each risk can be found in Appendix 1.

In our WRMP, the costs and benefits of all options considered to address the forecast supply-demand deficit to 2035 have been assessed, including social and environmental costs. The most economic combination of options has been chosen to form our water resources and demand strategy to maintain a sustainable supply-demand balance.

Based on our WRMP forecasts across the region we plan to implement demand reductions of 16Ml/d from water efficiency measures and 28.4Ml/d from leakage reduction actions by 2035 alongside development of 54Ml/d of reliable supplies from groundwater sources by 2035. It should be noted that demand reductions as a result of increased customer metering have been included in the demand forecast calculations. In accordance with the consultation response from Ofwat on our Draft WRMP, this excludes compulsory metering of existing unmeasured homes. However, we anticipate that in the longer term it will become a statutory requirement to meter all homes; this is consistent with UU's Strategic Direction Statement[7].

Beyond 2035, there is increased uncertainty around climate change predictions and associated risks, therefore no further schemes are proposed to address these risks at this time. However, we have identified additional sources that can be brought into supply in reasonably short timescales (3-5 year development timeframe) in response to confirmed additional impacts or an increased risk of climate change impacts. In particular, our adaptation plan in the WRMP focuses on the utilisation of sandstone aquifer resources in the Cheshire and Merseyside area, which are generally resilient to the climate change forecasts for North West England. Consequently, this provides a flexible water resource that can be brought into supply by the drilling of new boreholes. Additionally, further identified management measures will be considered alongside any source development taking account of capital, operational, environmental and social costs.

The requirements identified in our adaptation plan will be delivered within the usual regulatory and planning frameworks. Activities that have been identified to be carried out in the period 2010-2015 have been funded through the recent Ofwat regulatory price review process (PR09). Activities proposed for the period 2015-2020 will need to be included in the company's regulatory price review submission in 2014 accompanied by robust evidence to demonstrate the cost-benefit of the proposed expenditure. Beyond 2020, further funding approvals will be sought for specific adaptation solutions (demand management or source developments) identified in future regulatory price reviews (assuming no significant changes to the regulatory framework).

Table 9: Key to symbols

Climate variable	Symbol	Type of adaptation activity	Symbol	Costs	Symbol
Flood		Construction		Capex <£1M Opex <£0.5M/year	
Drought		Investigation/ desk top activity		Capex £1 - 10M Opex £0.5 - 2M/year	
Temperature rise		Partnership		Capex £10 - 50M Opex £2 - 5M/year	
Sea level rise		Changing behaviours		Capex >£50M Opex >£5M/year	

Table 10: Priority impacts and adaptation activities for the Water Service

Residual level of risk (score)	Risk ID / Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed / benefits
12	WR8 	Direct asset flooding leading to asset loss.		Carry out 2010-2015 flood protection programme. Review flood risks for the next regulatory submission and extend to include service reservoirs.	££	2010-2015	Ensures our assets are resilient to severe flooding in the short term with emergency plans in place to prevent disruption to supply.
				Review emergency electricity supply arrangements for all key assets.	£	2010-2015	
				Carry out flood protection programme and continue to plan for flood loss at highest risk sites.	££	2015-2020	
12	WR28 	Increased evapotranspiration, lower infiltration and borehole yields, reducing security of supply.		Review Climate Change impact on Water resources using UKCP09 and rainfall-runoff modelling.	£	2010-2015	This will improve UUW's understanding of CC risk in the North West for the next WRMP. Our adaptation plan in the current WRMP, used CP02 data and focuses on utilisation of sandstone aquifer resources in the Cheshire and Merseyside area, which are generally resilient to CC. Need to review this understanding with
				Re assess climate change risk on borehole Deployable Output using more sophisticated UKWIR methodology (looking at more	£	2010-2015	

Residual level of risk (score)	Risk ID / Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed / benefits
				intense rainfall events and increased evapotranspiration).			more sophisticated methods.
12	WT17 	More algal growth and micro-organisms in the water supply system	  	Complete 2010-2015 WTW and SCaMP investment and continue to maintain WTWs and water supply catchments. Need to further understand risks to those sites without appropriate treatment capability. Continue to closely monitor and review chlorine residual requirements throughout WTW to tap.	£££ £ £	2010-2015	Improve and maintain WTW treatment processes and catchment land. Protect against future risk of increased algal growth and general low quality raw water due to higher temperatures.
12	WT15 & WR19 	Tidal limits moving upstream and increasing salinity at intakes, impact on treatment		Review risks to identify likelihood (e.g. constant or spring tide) and develop mitigation/adaptation measures for River Dee and River Lune intakes.	£	2015-2020	Once risks of increasing tidal limits are understood mitigation and adaptation measures can be developed to ensure security of supply and prevent deterioration of raw water quality.
8	WR12	More intense rainfall events resulting potential impact on dams and associated		Continue statutory 10 yearly inspections of dams, supervising engineer reservoir inspections and maintenance programme.	££	2010-2015	This will improve reservoir safety and provide greater resilience to potential climate change impacts.

Residual level of risk (score)	Risk ID / Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed / benefits
		spillways.		Complete programme of work to enhance spillways design to prevent damage to masonry structures during intense rainfall events.	££		
8	WR30 	Exfoliation cracks in storage basins affecting coatings/seals, clay liner failure.		Carry out studies on impact of climate change on increased drawdown and duration of drawdown on earth embankments. Assess measures to protect upstream face of earth dams if required.	£	2015-2025	Improve reservoir safety if studies highlight adverse impact of climate change.
6	WR10  	Extreme weather events resulting in adverse raw water quality	   	Complete 2010-2015 WTW investment and continue to maintain WTWs. SCaMP investigation into correlation between land condition and raw water quality. Continue to deliver catchment management activities on UU owned and non owned catchments. Increase use of turbidity monitors for sites at risk of	££££ £ ££ £	2010-2015 2020-2025 2010-2015	Improve and maintain WTW treatment processes. Protect against future risk of increased algal growth and general low quality raw water due to higher temperatures. Prevent issues at source through catchment management and prevent infiltration into pipelines. Maintain sufficient disinfection in the network. Seek further R&D (e.g. UKWIR)

Residual level of risk (score)	Risk ID / Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed / benefits
				elevated turbidity as a surrogate for adverse water quality.			
6	WR27 	Increased evapotranspiration, lower surface reservoir yields; greater reliance on groundwater recharge, reducing security of supply.		Deliver Climate Change Investment (supply and demand actions) including West-East Link pipeline and South Egremont Boreholes.	£££	2010-2015	Ensuring a more resilient and adaptable water supply network with integrated resources to balance supply risks arising from climate change to maintain level of service for water supply for our customers.
				Review Climate Change impact on Water resources using UKCP09 and rainfall run off modelling. Also, review drought plan and standby sources available.	£	2010-2015	
				Reduce leakage by 28.4Ml/d and demand by 16Ml/d through demand management activities such as the water efficiency programme and customer metering	££££	2010-2035	
6	WT11 	Direct flooding of service reservoirs, contaminants enter underground storage tanks and pipelines.		Need to extend flood risk work to include service reservoirs.	£	2015-2020	Ensures our assets are resilient to flooding in the short term with emergency plans in place to prevent disruption to supply.

Residual level of risk (score)	Risk ID / Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed / benefits
6	WT3 	Reduced raw water volumes reducing dilution and water quality.	 	Review WTW treatment capabilities for sites where ground water and surface water sources are blended during droughts. Continue to deliver catchment management activities (SCAMP)	£ £££	2015-2020 2010-2015	Protects against future risk of drinking water quality problems, ensuring we continue to meet drinking water standards and the aesthetic quality of drinking water expected by our customers.

5.2 WASTEWATER SERVICE

UUW's adaptation plan for its Wastewater Service is provided in Table 11. These measures have been proposed to address the priority risks identified through the risk assessment workshops and are displayed in the yellow or red quadrants of Figures 16 to 18. A detailed description of each risk can be found in Appendix 1.

There are ten priority risks for wastewater network, eleven risks for wastewater treatment and two for sludge. The corresponding adaptation activities are outlined in Table 11 below.

Our adaptation plan for the wastewater service is focused on activities that will take place over the current and next asset management periods (2010-15 and 2015-2020). The outcome of these activities will inform our adaptation plans beyond 2020, when we will be more certain of the impacts of climate change on our business. We will be able to use our experience and the latest climate research to revise the risk assessment, identify adaptation activities where appropriate and develop stronger justification for funding.

The adaptation activities proposed will be delivered within the usual regulatory and planning frameworks. All proposed investment schemes are subject to cost-benefit assessment as part of this process. Activities proposed for the period 2012-2020 will need to be included in the company's regulatory price review submission to Ofwat in 2014 and be accompanied by robust evidence to demonstrate the cost-benefit of the proposed expenditure. The evidence will be compiled as we prepare the price review submission up to 2014. As a result of this work, any changes to the proposed adaptation actions in Table 11 will be updated. Beyond 2020, further funding approvals will be sought for specific adaptation activities identified through the ongoing revision of our adaptation plan.

As previously identified in this report, we currently do not routinely upsize our wastewater assets to take account of climate change. The adaptation activities we have identified for the short and medium term focus on working in partnership with other organisations to deliver innovative, sustainable management of climate impacts. For example, joint working with the EA and LAs on surface water management issues to address the impact of changing rainfall patterns. We recognise that we need a greater understanding of the potential impacts of climate change (what, where, how and when) on our Wastewater Service to identify and justify appropriate future investment.

Table 11: Priority impacts and adaptation activities for Wastewater

Residual level of risk	Risk ID / Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed / benefits
24	WWN1 	Increased volumes of storm water in combined sewers exceeds sewer capacity and causes customer flooding.		Short term – continue to upsize priority sections of sewer to alleviate hydraulic inadequacy and provide mitigation to customers.	££££	2010-2015	Provide an agreed level of protection to properties against sewer flooding.
				Investigation to enhance network models (coverage and capability).	£	2010-2015	Improve understanding of the detailed impact of supply/demand changes including climate change, and influence stakeholders to support investment in preventing service deterioration.
				Joint working with the EA and LAs on surface water management issues.	£	2010-2015	Establish a framework to share data, skills and expertise.
				Continue with our Integrated Asset Planning approach. Prioritise WwTWs and drainage networks according to their relative exposure to the impact of climate change.	£ £	2010-2015	Address spatial variation in changes in rainfall patterns by targeting investment needs. Ensure holistic and sustainable solutions are progressed. Support the achievement of

Residual level of risk	Risk ID / Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed / benefits
				Sustainable Urban Drainage (SUDS) demonstration project.		2010-2015	Integrated Urban Drainage (IUD) in the longer term (by 2035).
				Implement recommendations from the SUDS demonstration project.	£££	2015-2020	Significantly reduce the impact of changes in storm intensity on the sewerage system.
24	WwTW1 	Loss of power and treatment process leading to service failure.	 	Work with our energy supplier to identify critical sites and develop a plan to manage the risk of outages and service failure.	£	2010-2015	Put plans in place to manage the risk of power outages, including combined heat and power systems, at critical sites. Link to business continuity/resilience plans.
24	WwTW2 WwN2 WwS1 	Direct asset flooding leading to asset loss and service failure.	 	Develop flood risk plans for all sites through asset planning. Use CP09 scenarios to review climate change risk assessment and adaptation plans as part of ongoing asset planning.	£ £	2010-2015 2015-2020	Identify level of risk of sites to flooding and prioritise sites according to their current level of risk. Produce a plan to reduce the risk at the highest priority sites. Ensure that adaptation activities address the appropriate risks of climate change. The plan is flexible to respond in changing circumstances and formalise our

Residual level of risk	Risk ID / Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed / benefits
							actions when better information is available.
18	WwN3 	Direct asset flooding, storm damage and coastal erosion or planned retreat leading to asset loss and service failure.		Develop flood risk plans for all sites through asset planning.	£	2010-2015	Identify level of risk of sites to flooding and prioritise sites according to their current level of risk. Produce a plan to reduce the risk at the highest priority sites.
18	WwTW3 	Reduced base flow in receiving water courses leading to tighter discharge conditions. Increased risk of consent failure and pollution.	   	Piston effect study to investigate solutions to relieve the impact of rapid variation in inflows/dilution to WwTWs. Implement the investment identified by the piston effect study. Integrated Catchment Modelling (ICM) work with the EA to identify future water quality improvements required by legislation.	£ £ £	2010-2015 2015-2020 2010-2015	Identify investment needs for 2015-2020 and manage the impact of changing patterns of precipitation leading to a reduction in treatment process performance efficiency. Identify investment needs for 2015-2020 to achieve regulatory compliance with water quality legislation, manage the risk of reduced base flows and ensure a sustainable outcome. Identify investment needs for 2020-2025 to achieve regulatory

Residual level of risk	Risk ID / Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed / benefits
				Implement the investment identified by ICM and carryout further modelling to identify future water quality improvements in light of better information on climate impacts on base flows.	£££	2015-2020	compliance with water quality legislation, manage the risk of reduced base flows and ensure a sustainable outcome.
16	WwN4 	Lower average and peak sewer flows leading to settlement of solids with shock loads causing blockage of pass forward flow point and unconsented discharges.		Improved sewer monitoring and targeting of intervention on network to reduce service failure.	£	2010-2015	Improved understanding of asset operation in response to changes in precipitation. This will inform future adaptation plans.
				Identify investment requirements for 2015-2020.	£	2010-2015	
				Implement further investment in sewer monitoring. Build in the flexibility to remotely control the sewer network where possible.	££	2015-2020	Will enable us to respond to service failure more efficiently.
12	WwN5 	Lower average peak sewer flows leading to settlement of solids with shock loads causing more		Improved sewer monitoring and targeting of intervention on network to reduce service failure.	£	2010-2015	Improved understanding of asset operation in response to changes in precipitation.

Residual level of risk	Risk ID / Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed / benefits
		frequent blockages and customer flooding.		Identify investment requirements for 2015-2020.	£		
12	WwN6 	Lower average peak sewer flows leading to settlement of solids with shock loads causing increased CSO spills and deteriorating water quality in receiving water. Tighter discharge conditions may be imposed by EA.	   	Improved sewer monitoring and targeting of intervention on network to reduce service failure. Integrated Catchment Modelling (ICM) work with the EA to identify future water quality improvements required by legislation. Identify investment requirements for 2015-2020.	£ £ £	2010-2015	Improved understanding of asset operation in response to changes in precipitation. Identify investment needs for 2015-2020 to achieve regulatory compliance with water quality legislation, manage the risk of reduced base flows and ensure a sustainable outcome. Surface water management activities may remove the need for CSOs.
12	WwTW4 	Lower average and peak flows increasing need for recirculation and pumping.	 	Short term – adjust the flow control at WwTWs. Long term – change asset design standard to remove the need for recirculation.	£ £	2010-2015	Ensure future design standards take account of climate change.

Residual level of risk	Risk ID / Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed / benefits
				Review asset design standards against CP09 scenarios to identify unsustainable practices and amend for 2015-2020.	£		
12	WwTW5 	Shock loads result in increased asset deterioration and health and safety risk.		Review asset design standards against CP09 scenarios to identify unsustainable practices and amend for 2015-2020.	£	2010-2015	Ensure future design standards take account of climate change.
12	WwTW6 	Increased scepticism levels and odour.		Produce an odour management plan for all sites using a risk based approach. Identify sites where there is a case for investment.	£	2010-2015	Manage the health, safety, environmental and customer impact of odour according to the local risk presented.
				Implement the investment identified by odour management plans. Review the plans and identify further investment required.	£	2015-2020	
12	WwN7 	Higher storm intensity means CSOs spill more frequently, impacting on receiving water quality.		Short term – continue to increase sewer network capacity.	£££	2010-2015	Provide an agreed level of protection against water quality deterioration.
				Long term – surface water management activities.	£££		Support the achievement of Integrated Urban Drainage (IUD) in the longer term (by 2035). Significantly reduce the impact of

Residual level of risk	Risk ID / Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed / benefits
				Sustainable Drainage Systems (SUDS) demonstration project.	£		changes in storm intensity on the sewerage system. Address spatial variation in changes in rainfall patterns by targeting investment needs. Ensure holistic and sustainable solutions are progressed.
				Continue with our Integrated Asset Planning approach. Prioritise WwTWs and drainage networks according to their relative exposure to the impact of climate change.	£		
12	WwN8 	Increased storm water flows require increased pumping in combined sewers, causing accelerated asset deterioration.		Short term – continue to maintain assets.	£££	2010-2015	Existing assets and operation supports a stable level of service.
				Long term – change asset design standard to accommodate changing use.	£		Ensure future design standards take account of climate change.
				Review asset design standards against CP09 scenarios to identify unsustainable practices and amend for 2015-2020.	£		
12	WwS2	Flooding and/or saturated ground prevents access to fields to dispose of		Increased capacity of sludge incineration plant.	£££	2010-2015	Provides an alternative means of sludge disposal should the land bank for recycling be unavailable due to the impact of climate

Residual level of risk	Risk ID / Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed / benefits
		sludge.		Produce detailed action plan identifying alternative disposal routes. Carry out modelling work to identify land areas for sludge recycling at risk from flooding.	£ £	2015-2020	change. Improved understanding of the risk from climate change to our sludge to land operations and identify further adaptation actions where necessary.
8	WwTW8 	Extended duration at flow to full treatment due to increased rainfall and/or storage return. Accelerated asset deterioration and failure.	   	Assess the need to change the asset design standards to accommodate this mode of operation. Investigation/trial UV treatment of storm discharges. Identify investment required in 2015-2020. Review asset design standards against CP09 scenarios to identify unsustainable practices and amend for 2015-2020. Implement the investment identified by the UV trial.	£ £ £ £££	2010-2015 2010-2015 2015-2020	Ensure future design standards take account of climate change. Address potential septicity, odour, treatment and water quality issues resulting from increased volumes of storm water.

Residual level of risk	Risk ID / Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed / benefits
8	WwTW7 	Changes in domestic waste disposal practices lead to changes in dry weather flow pollutants, affecting treatment processes.		Continue involvement in national R&D work on this issue.	£	2015-2020	Address wider issue of sustainability of domestic waste disposal (alternative to landfill) and identify measures to mitigate impact on wastewater treatment processes.
6	WwN11 	Lower average and peak flows leads to hydrogen sulphide build up in the sewers causing accelerated asset deterioration.	 	Short term – increase chemical dosing into sewers and at WwTWs to prevent gas creation. Long term- change the asset design standards to accommodate or withstand corrosion.	£ £	2010-2015	Protect existing assets against corrosion. Ensure future design standards take account of climate change.
6	WwN12 	Runoff exceeds combined sewer capacity leading to surface flooding and pollution.		Involvement in national work on the management of flooding from sewer to land under the Waste Regulations.	£	2010-2015	Agreement on the framework for regulating sewer discharges to land.

5.3 SUPPORT SERVICES

UUW's adaptation plan for its Support Services is provided in Table 12. These measures have been proposed to address the priority risks identified through the risk assessment workshops and are displayed in the yellow or red quadrants of Figure 19. A detailed description of each risk can be found in Appendix 1.

There are five priority risks for support services that are not already being addressed, all placed in the lower yellow quadrant of Figure 19. The corresponding adaptation activities are outlined in Table 12 below.

The adaptation activities proposed are not subject to the same regulatory framework as the Water and Wastewater Services and can be undertaken as part of our usual business process. They are primarily driven by the need to increase resilience and ensure business continuity, however, they have benefits for climate change adaptation. For example, we will be working with our suppliers to help them understand the risks of climate change and how to adapt to them.

Table 12: Priority impacts and adaptation activities for Support Services

Residual level of risk	Risk ID / Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed / benefits
16	SS6 LEGAL	Increase in insurance premiums as a result of increase in claims related to climate change impacts.		Review the type and number of claims to inform work to reduce or remove the risk where appropriate.	£	2010-2015	Reduce potential financial impact of insurance claims on UUW.
12	SS3 SUPPLY CHAIN	Suppliers are not aware of climate change risks.	 	Work with suppliers to help them adapt to the impacts of climate change.	£	2010-2015	Increase UUW's resilience to climate change impacts through joint working with our suppliers.
12	SS8 HR	Staff are unable to commute to work during extreme events.	 	Identify lessons learnt from previous events and put measures and actions in place. Work with operational delivery partners to identify potential resources for these events.	£ £	2010-2015 2010-2015	A sustained level of service can be provided to customers.

Residual level of risk	Risk ID / Climate variable	Impact and consequence for assets and operations	Type of activity	Adaptation activity	Cost	Time scale	Risks addressed / benefits
12	SS9 HR 	Impact of a heat wave on the health and safety of staff.		Use study by NHS to inform actions. Continue to monitor and implement health and safety policies related to hot weather risks.	£	2010-2015	Protect staff from the impacts of climate change.
12	SS10 PROPERTY 	Risk of flooding of office buildings.		Extend resilience work already completed for key operational sites to cover all buildings at risk from flooding.	£	2010-2015	Identify sites at risk of flooding and invest in protection where justified on cost-benefit grounds.

5.4 OPPORTUNITIES

Our risk assessment workshops have enabled us to identify some potential opportunities associated with climate change. It is too early in the process to be able to quantify the potential benefits, however it was felt that the items listed in Table 13 would have a positive impact on our business. Similarly, the time at which these will be realised is, as yet, unknown. It is important to note that the impact of increased temperature is expected to be beneficial to the sludge treatment process. However, the same impact was not considered by our wastewater treatment experts to have a significant impact on the wastewater treatment process.

Given the current anticipated climate change projections for the Northwest, we have been unable to identify any opportunities for UUW's Water business.

Table 13: Opportunities

Business area	Climate variable	Impact and opportunity
Wastewater treatment		Increased rainfall leads to increased flows in rivers and greater dilution for effluent discharges. Risk of non compliance with existing consent is reduced. Potential for seasonal consents with relaxed standards during the winter.
Wastewater network		Increased rainfall leads to increased flows in rivers and greater dilution of intermittent discharges. Water quality impact of sewer overflows is reduced. Overall water quality improves.
Wastewater sludge		Drought conditions and increased evaporation leads to a high soil moisture deficit. Sludge becomes a more desirable agricultural product because of its high water content.
Wastewater sludge		Warmer temperatures enable increased microbial activity and increased biogas production. Processing plants become more self-sufficient on power generation.
Wastewater sludge		Warmer temperatures reduce the heating requirement for sludge digestion. The performance of the assets is improved.
Water and Wastewater service		Better working relationships with key stakeholders and regulators as we address the barriers and interdependencies needed to progress the adaptation activities.

6 UNCERTAINTIES AND ASSUMPTIONS

Our climate change risk assessments and associated adaptation plans are underpinned by data that necessarily exhibits a wide range of uncertainty due to the difficulties inherent in climate modelling and forecasting, and the translation of those climate change forecasts to second and third order effects such as flooding and drought at the catchment-scale. Similarly, we have had to make assumptions to support the risk assessment and adaptation plans.

The key uncertainties and assumptions are summarised in Tables 14 and 15:

Table 14: Key uncertainties in risk assessments and adaptation planning

Uncertainty	Impacts	Response	Scale of impact
High level of uncertainty with CP09 predictions	Emissions scenarios chosen Level of probability chosen	High emissions chosen (no international agreement to reduce global emissions) 50% probability chosen ((all other probabilities are too extreme)	Minor for 25 year horizon
Future structure of the water industry in England and Wales i.e. vertical separation.	Prioritisation and coordination of adaptation actions would be more difficult.	Assume current structure continues	Minor
How environmental legislation and associated policies of the EU, UK Government and our regulators will be adapted in the face of climate change.	Water Framework Directive objectives and targets may be altered to reflect future climate conditions.	Assume current structure continues	Major
How national, regional and local planning will respond to climate change threats.	Demographic changes with associated implications for demand for water and wastewater services.	Already using the best available information	Minor for 25 year horizon
How other key stakeholders will adapt to climate change	The ability and scale of adaptation required	Highlighted in the interdependencies section	Could be major

Table 15: Key assumptions in risk assessments and adaptation planning

Assumption	Rational	Response
Climate change will continue to be a relatively gradual, incremental change rather than materialise in a catastrophic, step-change event.	CP09 data suggest that is the likely path.	Use CP09 data.
Current structure of the water industry in England and Wales remains unchanged.	No definitive information on other structures.	Assume UUW continues as currently structured.
UUW remains a privately-owned company with a mixed debt/equity funding structure, and is able to access the debt and equity markets to finance the expenditure required to adapt to climate change.	No evidence to state otherwise.	Assume UUW continues as currently structured.
UUW will continue to work in partnership with other utility companies and the public sector on integrated urban drainage and Surface Water Management Plans.	Legislation is driving all parties down the partnership route.	Current partnership working is further enhanced in future.
Existing emergency planning and response capabilities of Category 1 and Category 2 responders (as defined in the Civil Contingencies Act 2004) remain in place.	No evidence to state otherwise.	Assume existing structure remains.

7 BARRIERS AND INTERDEPENDENCIES

It is important to recognise and address the potential barriers to adapting to climate change in order to deliver an effective adaptation programme. Table 16 below outlines the barriers we have identified through the production of this report along with mitigating actions. The barriers are consistent with the findings of three key national-scale documents [31] [32] [33].

Table 16: Barriers and mitigating action

Barriers to implementing the UUW adaptation programme	Mitigating action (how the barriers will be addressed)
Cost: Adaptation measures for infrastructure enhancement, particularly if based on 'hard' engineering solutions may have a high cost. Therefore adequate funding may not be available to implement these solutions. This may be particularly relevant to adaptation measures proposed for the sewerage network as this has been subject to only limited expenditure since privatisation and hence resilience is lower compared with other key expenditure areas.	Each measure will be subject to cost benefit analysis with the most cost effective measures being prioritised.
Affordability: Affordability, i.e. impact on individual customer bills. In periods of economic constraints customers (tax payers) may be unwilling or unable to see bills increase to pay for climate change adaptation. This may be reinforced by a limited understanding of climate risks and vulnerabilities and/or a belief that the uncertainty is currently too great to warrant taking immediate action. Affordability may also be a constraint for the country as a whole, as work on adaptation to climate change may divert expenditure from other areas of the economy.	We conduct willingness to pay surveys with our customers to determine the amount (if any) extra they are willing to pay for climate change adaptation activities. An up-front explanation and briefing to customer focus groups of climate risks as part of the willingness to pay survey. We would expect this issue to be assessed by Ofwat as part of their regulatory review of our business plans.

[31] Department for Transport (2010) Local and Regional Climate Change Research http://www.dft.gov.uk/pgr/regional/policy/climatechange/pdf/report100715.pdf

[32] PricewaterhouseCoopers LLP (2010) Adapting to climate change in the infrastructure sectors

[33] HM Treasury (2010) National infrastructure plan http://www.hm-treasury.gov.uk/d/nationalinfrastructureplan251010.pdf

Barriers to implementing the UUW adaptation programme	Mitigating action (how the barriers will be addressed)
Resources: Availability of adequate resources, e.g. technical, engineering and scientific, across the country to deliver climate change adaptation measures.	Work with government departments, educational establishments, industry bodies etc to increase capacity in these areas.
Knowledge: Uncertainties associated with UKCIP forecasts and the associated impact on sewerage and water networks may make the definition of effective adaptation measures problematic. In making the case for future investment there needs to be a sound evidence base to justify the benefit of potential investment.	Continue research and development projects, as UUW and in collaboration with industry bodies and government departments to agree the evidence base necessary to justify investment in adaptation.
Timing: Future updates to UKCIP scenarios need to be released in time to inform the price review process, to provide clarity for water companies and their regulators.	See Figure 19.
Adequate visibility of other utility plans: Lack of timely visibility of the adaptation plans of other key infrastructure and utility owners may result in the development of sub optimal adaptation plans by all utility providers. Infrastructure systems are only as strong as the "weakest link". Therefore sewerage networks that are designed to 1 in 30 year events that lead to flooding will impact on the efficacy of the operation of other key infrastructure. For example electricity substations designed to resist 1 in 100 year events that are close to sewers that are prone to flooding would need greater protection measures, and hence adaptation plans need to be shared to identify such scenarios.	We believe that the requirement for preparing statutory adaptation plans will enable closer working and co-operation on climate change adaptation plans across key infrastructure and utility owners. We look to Defra to help facilitate this as part of their overall assessment of statutory adaptation plans.
Regulations and legislation: Lack of supportive legislation, guidance, regulations, policies etc, by Government or Regulators, may present impediments to the delivery of cost effective adaptation programmes.	We are currently working with these bodies and plan to continue this work to ensure that appropriate legislation, guidance etc is produced in a timely manner.
Carbon impact: Adaptation measures may themselves contribute to carbon emissions and therefore accelerate climate change. This will be particularly relevant to those based on 'hard' engineering solutions.	We will work with our regulators to agree a balance between adaptation activities and the increase in carbon that these bring about.

We have recognised that there are many interdependencies associated with delivering our adaptation programme. These interdependencies need to be addressed in order to deliver an effective adaptation programme for our business, the water industry and the UK as a nation. It is paramount that all the sectors work in partnership and are guided by government policy to ensure that they are realised as opportunities rather than barriers. Table 17 below outlines the interdependencies we have identified through the production of this report along with mitigating actions.

Table 17: Interdependencies and mitigating action

Interdependencies with the UUW adaptation programme	Mitigating action
Energy: Ability to ensure a consistent supply. No visibility of the potential climate change impacts on them and therefore on us	Develop a more integrated approach to risk management with our energy suppliers.
Telecoms: Ability to ensure a consistent supply No visibility of the potential CC impacts on them and therefore on us Engagement from the sector needs to be improved	Develop a more integrated approach to risk management with our telecoms provider.
Environment Agency: Knowledge of how they will alter our discharge consents in the future Knowledge of how they will alter our abstraction licences in the future Future flood defence strategies Awareness of flood risk	Improve existing working relationships across all these areas to ensure an integrated and sustainable approach to future regulatory requirements.
Ofwat: Current regulatory framework does not always facilitate delivery of sustainable investment	Work with Ofwat to ensure an integrated and sustainable approach to future regulatory requirements.
Local Authorities: Impact of their new flood risk management duties and responsibilities and their ability to undertake them Impact of SUDS on the whole planning process	Improve existing working relationship to further support LA's in implementing their new duties.
Government: E.g. Defra, CLG. Implementing appropriate legislation to address the barriers and interdependencies. Coordination of adaptation activities.	We expect the Government to implement the recommendations from the Pitt Review and the Floods and Water Management Act. Improved joint working with government departments and other stakeholders to resolve issues associated with

Interdependencies with the UUW adaptation programme	Mitigating action
Customer demand for water and wastewater services. Local and regional plans for development.	interdependencies. Continue our engagement with planning bodies to forecast future demographic changes and with industry to understand their future requirements.
UKCIP: Climate change experts need to continue to improve forecasting to enable the risks to be assessed and adaptation plans informed.	We will continue to work with UKCIP to ensure the information produced is appropriate.

A good example of interdependent organisations working together to manage a particular issue is given in Case study Box 6.

Case study Box 6: Emergency planning – working together under the Civil Contingencies Act 2004

Emergency planning is a good example of interdependent organisations working together to manage a particular issue, especially where it is driven by legislation. It is possible that a similar framework could be established to address the interdependencies of adapting to climate change.

UUW fully complies with and resources our obligations under the Civil Contingencies Act 2004. As a Category 2 responder under the Act we have a responsibility for emergency planning arrangements and are part of the Local Resilience Forum – a strategic coordination group.

The main climate-related impacts driving emergency plans have been realised through floods and severe weather incidents. This is illustrated by the history of events in Table 1. However, the remit of the resilience work is focused on the current level of risk to infrastructure from these climate-related incidents. The focus needs to be extended to consider the future risk and potential impacts.

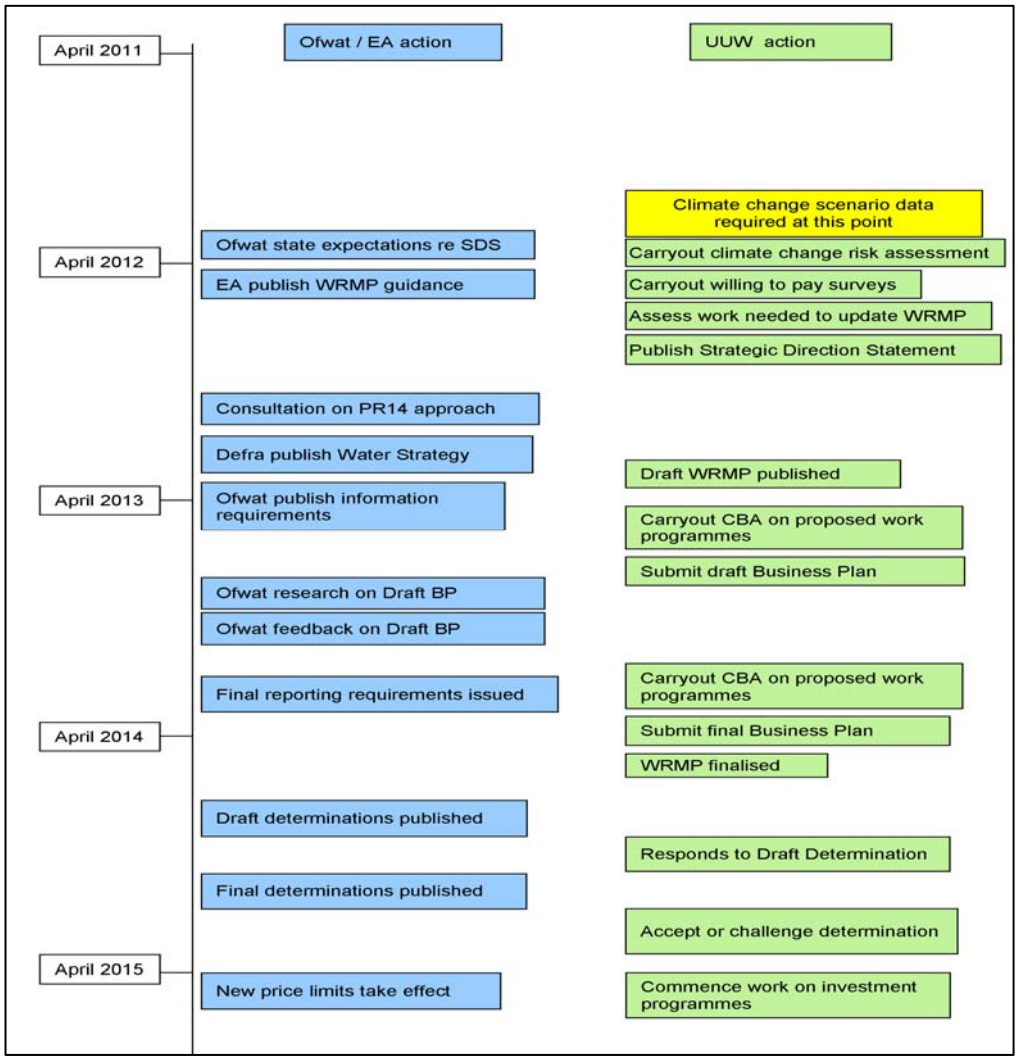
The current review of the vulnerability of Critical National Infrastructure (CNI) by Defra is looking at climate change alongside other potential impacts on the ability of utilities and other essential services function. The urgency of this work is driven by the 2007 floods and subsequent recommendations in the Pitt Review. We expect the outcome of the CNI review to indicate our future role in emergency planning.

8 MONITORING AND EVALUATION

Climate change risk is already an integral part of our business risk and asset planning processes. This means that the risks and associated adaptation strategies will be reviewed on a regular basis by the UUW Board, Directors and senior managers in line with all of the company's other key business risks and delivery plans. Directors and their line managers will have direct accountability for reviewing the risks and delivery of the plan for their areas of control.

The progress of the adaptation actions that are currently in our 2010 to 2015 investment programme will be monitored in the same manner as any other investment project. Those proposed for future investment periods will be reconsidered as the detailed business plans for each regulatory price review are prepared and in light of the latest evidence. Figure 20 outlines the timetable as we currently understand it for the next price review. It is critical that issues relating to our interdependencies are resolved in sufficient time to enable our adaptation plan to be supported by our regulators through this process.

Figure 20: Timetable for regulatory submissions



It is important to note the stage highlighted in yellow (Figure 20). A new set of CIP scenarios is required at this point in the process in order for any new/altered impacts to be addressed through the next planning cycle (2015-2020). We plan to formally review our adaptation plan on at least a five-yearly cycle (to ensure consistency with current business planning process), with additional formal reviews taking place in the event of significant new information becoming available (e.g. a new set of UKCIP scenarios) or any significant changes that affect the adaptation plan. Our adaptation plan could be updated at any point in this cycle, however by January 2015 we will have received our final determination from Ofwat, detailing the amount of investment allowed for our business plan, including climate change adaptation plans. We may need to reassess the risk scores if the associated adaptation activity is not funded.

The effectiveness of each action will be evaluated when the risk assessment process is updated (i.e. current risks should have a substantially lower score or be totally removed if the action has been successful). This method of evaluation is in line with the desire of ensuring a continual cycle of risk assessment and action.

As mentioned previously, it has not been possible to identify specific climate related thresholds e.g. a 5^{o} rise in temperature or a 20% increase in rainfall that would pose a significant risk to UUW. This may be possible in future if more detailed climate change data becomes available and more detailed assessments are undertaken.

In addition, the company will continue to report on progress with climate change adaptation plans to its key regulators on an annual basis (e.g. June Return to Ofwat and Water Resources Management Plan reviews to the Environment Agency). The company has a Climate Change Adaptation Manager within its Asset Management directorate who will take the lead in ensuring the risk assessments are reviewed and plans are being delivered across the company.

Whilst climate change has been on the company risk register for a number of years and we have been involved in related activities since the early 1990s, the preparation of this report has resulted in a number of changes within the business:

- Formulation of a consistent company wide assessment process for climate change risks.
- Implementation of the above process.
- Increased awareness of the issue.
- Increased awareness of the work already ongoing.
- Raised awareness of the future work proposed.

We will update this report by mid-2015 and provide a copy to Defra.

9 REFERENCES

[1] Defra (2009) Adapting to Climate Change: helping key sectors to adapt to climate change. Statutory guidance to reporting authorities.
http://www.defra.gov.uk/environment/climate/documents/statutory-guidance.pdf

[2] http://www.unitedutilities.com/WaterResourcesPlan.aspx

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10 APPENDICIES

A Risk assessments

A.1. Water Service spreadsheets

A.2 Wastewater Service spreadsheets

A.3 Support Services spreadsheets

B Climate change projections considered in our report

C Defra statutory guidance box 2

D Cranfield evaluation framework

APPENDIX A. RISK ASSESSMENTS

Guidance criteria used in workshops for consequence and likelihood assessment

Level of consequence (1-8)		
Severe	**8**	Failure of corporate objectives with a detrimental impact to the corporate strategy Total lack of confidence from a large number of stakeholders An actual reduction in shareholder value
High	**6**	High impact to corporate objectives High levels of stakeholder concern with a potential impact to shareholder value
Medium	**4**	Detrimental to meeting corporate objectives but not necessarily of a material nature Would attract the interest or interaction from various stakeholders
Low	**2**	Impact to the efficiency and effectiveness of meeting corporate objectives, but largely insignificant to corporate materiality

Level of likelihood (1 - 4)		
Very Likely 71 - 99%	**4**	It is very likely the consequence will occur by 2035
Likely 41 - 70%	**3**	It is likely the consequence will occur by 2035
Unlikely 11- 40%	**2**	It is unlikely the consequence will occur by 2035
Remote <10%	**1**	It is remote that the consequence will occur 2035

A.1. WATER SERVICE

Water resources – treatment - network

						2035							
						Company's initial risk				Company's residual risk			
ID	ASSET LEVEL 2	ASSET LEVEL 3	CLIMATE VARIABLE	IMPACT	CONSEQUENCE FOR ASSETS & OPERATIONS	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Likelihood)	Detail of adaptation actions already being undertaken	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Likelihood)	Proposed action to mitigate residual risk
WT20	WATER TREATMENT	Treatment works	TEMP. RISE	Higher temperatures	impacts on treatment process	4	3	12	Management of the treatment process should partly address this risk.	4	2	8	Need to further understand risks to those sites without appropriate treatment capability. Complete AMP5 investment assumed, plus continue to maintain WTWs. Look at chlorine residual requirements throughout WTW to tap system
WT22	WATER TREATMENT	Service Reservoirs & Water Towers	TEMP. RISE	Increased micro-biological growth,	higher risk of residual chlorine depletion, contamination of supplies	4	3	12	Existing chlorine residual targets reviewed regularily	4	2	8	Review risks and assess any structural changes to chlorination approach in WTW to tap system
WN16	WATER NETWORKS	Distribution networks incl. ancillaries	TEMP. RISE	Increased micro-biological growth,	higher risk of residual chlorine depletion, contamination of supplies	4	3	12	Existing chlorine residual targets reviewed regularily	4	2	8	Review risks and assess any structural changes to chlorination approach in WTW to tap system
WN18	WATER NETWORKS	Distribution storage	TEMP. RISE	Increased micro-biological growth,	higher risk of residual chlorine depletion, contamination of supplies	4	3	12	Existing chlorine residual targets reviewed regularily	4	2	8	Review risks and assess any structural changes to chlorination approach in WTW to tap system
WR11	WATER RESOURCES	Boreholes / source pumping stations	FLOOD	More intense rainfall compacting upper soil layers,	more run-off, less recharge of aquifers, lower security of supply	4	2	8	UKWIR CC assesment correlates rainfall and groundwater levels.	4	2	8	Need to re assess risk using more sophisticated UKWIR methodology
WN15	WATER NETWORKS	Distribution networks incl. ancillaries	TEMP. RISE	More extreme wetting and drying cycles	greater soil movement, more pipe movement and bursts	4	2	8	Current leakage and mains maintenance programmes	4	2	8	Continue to deliver mains maintenance and leakage programmes in line with company business plan/WRMP plus review impact with the rest of water and pipeline industry as to need to change any materials or mains laying processes
WR10	WATER RESOURCES	Raw water pipelines	FLOOD	Flooding	infiltration into pipelines	6	3	18	WTWs designed to deal with ingress ingress already. Raw water monitoring	2	3	6	Increased use of turbidity monitors for at risk sights. Ensure new/refurbished WTW take account of risk at these sites
WR27	WATER RESOURCES	Storage Reservoirs & Aqueducts	TEMP. RISE	Increased evapotranspiration	lower surface reservoirs yields; greater reliance on groundwater recharge, reducing security of supply	4	3	12	Evaporation risks included in UKWIR CC assessments and in WRMP CC assessments	2	3	6	Assumes CC investment in WRMP delivered before 2035. Continue to review as part of rainfall runoff modelling improvements
WT3	WATER TREATMENT	Treatment works	DROUGHT	Reduced raw water volumes reducing dilution	Poor water quality	2	3	6	No specific additional actions compared to current situation	2	3	6	Review WTW treatment capabilities for sites where blend GW in to SW sources during droughts

Water resources – treatment - network

						2035							
						Company's initial risk				Company's residual risk			
ID	ASSET LEVEL 2	ASSET LEVEL 3	CLIMATE VARIABLE	IMPACT	CONSEQUENCE FOR ASSETS & OPERATIONS	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Liklehood)	Detail of adaptation actions already being undertaken	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Liklehood)	Proposed action to mitigate residual risk
WT11	WATER TREATMENT	Service Reservoirs & Water Towers	FLOOD	Direct flooding	contaminants enter underground storage tanks and pipelines	2	3	6		2	3	6	Need to extend flood risk work to include service reservoirs.
WR1	WATER RESOURCES	All Water Resources	DROUGHT	Reduced available supply	reduced security of supply	6	4	24	WRMP, Drought plan, Integrated Resource Zone, East -West link	2	2	4	Assumes CC investment in WRMP delivered before 2035
WR4	WATER RESOURCES	All Water Resources	DROUGHT	Lower river & borehole yields or reduced water quality,	lower yields, increasing demand on existing storage, reducing in security of supply	6	3	18	WRMP, Drought plan, Integrated Resource Zone, East -West link	2	2	4	Assumes CC investment in WRMP delivered before 2035
WR3	WATER RESOURCES	All Water Resources	DROUGHT	Intake, borehole pump and reservoir draw-off levels do not match reduced levels	Loss of supply to WTW	6	2	12	WRMP, Drought plan, Integrated Resource Zone, East -West link. Dead water figures already based on lowest draw off level so no additional impact on IR sources (IR's account for c. 55% of supply)	2	2	4	Already design intakes to lowest drought levels. Review vulnerable BH sources where low storage and river intakes to assess risk at very low flows
WR5	WATER RESOURCES	Boreholes / source pumping stations	DROUGHT	Lower groundwater levels	reducing borehole yields, reducing security of supply	6	2	12	WRMP, Drought plan, Integrated Resource Zone, East -West link	2	2	4	Assumes CC investment in WRMP delivered before 2035
WR7	WATER RESOURCES	Intake Pumping stations	DROUGHT	River levels fall,	reduced reliablity as water sources, reducing security of supply	6	2	12	WRMP, Drought plan, Integrated Resource Zone, East -West link	2	2	4	Assess risks to river pumping stations of reduced lowest fistoric flows/ levels in river
WR9	WATER RESOURCES	All Water Resources	FLOOD	More frequent storms and power supply flooding,	power outages	6	2	12	Back up generators at all critical sites plus regional emergency generators can be deployed	4	1	4	Continue to review emergency electricity supply arrangements for all key assets
WT1	WATER TREATMENT	All Water Treatment	DROUGHT	Low flows	inability of assets to operate	6	2	12	Integrated Resource Zone, East -West link, WRMP, Drought Plan and standby sources	2	2	4	Consider CC assessed source reliable yields in designing minimum throughput of all new/refurbished WTW, alongside improved dosing controls
WT9	WATER TREATMENT	All Water Treatment	FLOOD	More frequent storms and power supply flooding,	power outages	6	2	12	Back up generators at all critical sites plus regional emergency generators can be deployed	4	1	4	Continue to review emergency electricity supply arrangements for all key assets

Water resources – treatment - network

2035

						Company's initial risk				Company's residual risk			
ID	ASSET LEVEL 2	ASSET LEVEL 3	CLIMATE VARIABLE	IMPACT	CONSEQUENCE FOR ASSETS & OPERATIONS	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Likelihood)	Detail of adaptation actions already being undertaken	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Likelihood)	Proposed action to mitigate residual risk
WT10	WATER TREATMENT	Treatment works	FLOOD	Increased runoff	higher sediment levels	4	3	12	Catchment management programes e.g SCAMP and drinking water saftey plans	2	2	4	Assumes SCAMP investment delivered
WN9	WATER NETWORKS	All Water Networks	FLOOD	More frequent storms and power supply flooding,	power outages	6	2	12	Integrated supply system and duty standby arrangements. Back up generators at critical sites and regional emergency generators can be deployed. Large no. of SRs to provide security of supply during power outages	4	1	4	Continue to review emergency electricity supply arrangements for all key assets
WN8	WATER NETWORKS	All Water Networks	FLOOD	Direct asset flooding	asset loss	4	2	8	Flood risk study as part of price review process agaisnt current 1:1000 event	4	1	4	Carry out AMP5 flood protection programe and review risks for AMP6 submission. Continue to plan for flood loss at highest risk sites with supply mitigation plans
WN10	WATER NETWORKS	Distribution networks incl. ancillaries	FLOOD	Flooding	infiltration into pipelines	4	2	8	Depends which pipeline -HA highest risk	4	1	4	Assumes carry out planned maintenance on HA before 2035 (starts in AMP 5)
WR2	WATER RESOURCES	All Water Resources	DROUGHT	Higher daily & peak demand for garden watering,	lower security of supply	2	3	6	WRMP, Drought plan, Integrated Resource Zone, East -West link. Existing supply system designed for peak demand greater than forecast increase in peak demand due to recent reductions in demand (c. 300Ml/d reduction)	2	2	4	Assumes WRMP actions for CC delivered (supply and demand management actions) continue to design new/ refurbished assest to meet predicted future peak demand with CC risk built in
WR23	WATER RESOURCES	All Water Resources	TEMP. RISE	Higher daily and peak domestic and commercial demand,	reduced security of supply	2	3	6	WRMP, Drought plan, Integrated Resource Zone, East -West link. Existing supply system designed for peak demand greater than forecast increase in peak demand due to recent reductions in demand (c. 300Ml/d reduction)	2	2	4	Assumes WRMP actions for CC delivered (supply and demand management actions) continue to design new/ refurbished assest to meet predicted future peak demand with CC risk built in
WN5	WATER NETWORKS	All Water Networks	DROUGHT	Higher daily & peak demand for garden watering,	increased asset use, faster asset deterioration	2	3	6	Not considered likely for pipes but faster deterioration for pumps	2	2	4	Review types of pumps and maintenance schedules to ascertain current asset life of motors/mechanical parts with higher usage at max output
WN17	WATER NETWORKS	Distribution storage	TEMP. RISE	Higher peak demand	leading to greater storage requirements reducing security of supply	2	3	6	WRMP, Drought plan, Integrated Resource Zone, East -West link. Existing supply system designed for peak demand greater than forecast increase in peak demand due to recent reductions in demand (c. 300Ml/d reduction)	2	2	4	Assumes WRMP actions for CC delivered (supply and demand management actions) continue to design new/ refurbished assest to meet predicted future peak demand with CC risk built in
WR15	WATER RESOURCES	All Water Resources	SEA LEVEL	Direct asset flooding, storm damage, coastal erosion or planned retreat	asset loss	4	1	4	No actions as no assets are sufficiently close to the sea to be affected	4	1	4	No further actions

Water resources – treatment - network

						2035							
						Company's initial risk				Company's residual risk			
ID	ASSET LEVEL 2	ASSET LEVEL 3	CLIMATE VARIABLE	IMPACT	CONSEQUENCE FOR ASSETS & OPERATIONS	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Likelihood)	Detail of adaptation actions already being undertaken	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Likelihood)	Proposed action to mitigate residual risk
WR17	WATER RESOURCES	All Water Resources	SEA LEVEL	Movement of permanent population (eg away from flood plains) and tourism due to flooding,		4	1	4	WRMP, Drought plan, Integrated Resource Zone, East -West link	4	1	4	Assess risk of this happening in future WRMPs
WR24	WATER RESOURCES	All Water Resources	TEMP. RISE	Higher temperatures and longer growing season	redistribution of / increase in agricultural demand and impacts on security of supply	2	2	4	WRMP, Drought plan, Integrated Resource Zone, East -West link.	2	2	4	Need to assess explicit risks in zones with higher than average agricultiral demands (e.g Southport, Vale Royal, Eden DMZs) on the public water supply
WR25	WATER RESOURCES	All Water Resources	TEMP. RISE	Redistribution of permanent population with warmer conditions,	reduced security of supply	4	1	4	WRMP, Drought plan, Integrated Resource Zone, East -West link.	4	1	4	Continue to review in subsequent WRMP population forecasts
WT12	WATER TREATMENT	All Water Treatment	GENERAL	Relocation of population from weather, flooding, sea level rise	affecting supply-demand balance, treatment works, asset capacity etc	4	1	4	WRMP, Drought plan, Integrated Resource Zone, East -West link	4	1	4	Assess risk of this happening in future WRMPs
WT14	WATER TREATMENT	All Water Treatment	SEA LEVEL	Direct asset flooding, storm damage, coastal erosion or planned retreat	asset loss	4	1	4	No actions as no assets are sufficiently close to the sea to be affected	4	1	4	No further actions
WT21	WATER TREATMENT	Treatment works	TEMP. RISE	More frequent disease increasing drinking water quality risk	additional potable water standards	4	1	4	Suitable treatment processes in place	4	1	4	Complete AMP5 investment assumed, plus continue to maintain WTWs. Look at chlorine residual requirements throughout WTW to tap system
WT23	WATER TREATMENT	Service Reservoirs & Water Towers	TEMP. RISE	More extreme wetting and drying cycles	greater soil movement, more pipe movement and bursts	2	2	4	Routine inspections and maintenance in place	2	2	4	Continue routine inspections and maintenance
WN13	WATER NETWORKS	All Water Networks	SEA LEVEL	Direct asset flooding, storm damage, coastal erosion or planned retreat	asset loss	4	1	4	No actions as no assets are sufficiently close to the sea to be affected	4	1	4	No further actions
WT2	WATER TREATMENT	Treated water pumping stations	DROUGHT	Loss of supply and depressurisation of the supply network,	more air blockages	4	2	8	Integrated Resource Zone, East -West link, WRMP, Drought Plan and standby sources	2	1	2	Consider CC assessed source reliable yields in designing minimum throughput of all new/refurbished pumping stations and include variable speed pumps at critical sites so can operate at low flows
WN1	WATER NETWORKS	Distribution networks incl. ancillaries	DROUGHT	Loss of / intermittent supply	increased risk of external contaminants entering supply pipelines	4	2	8	Integrated Resource Zone, East -West link, WRMP, Drought Plan and standby sources	2	1	2	Nothing further required if WTWs and pumping stations addressed

Water resources – treatment - network

						2035							
						Company's initial risk				Company's residual risk			
ID	ASSET LEVEL 2	ASSET LEVEL 3	CLIMATE VARIABLE	IMPACT	CONSEQUENCE FOR ASSETS & OPERATIONS	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Likelihood)	Detail of adaptation actions already being undertaken	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Likelihood)	Proposed action to mitigate residual risk
WR29	WATER RESOURCES	All Site wide Services	DROUGHT	Relocation of population from drought	affecting supply-demand balance and other aspects	6	1	6	Integrated Resource Zone, East -West link, WRMP, Drought Plan and standby sources	2	1	2	Actions incorporated above
WR20	WATER RESOURCES	All Water Resources	TEMP. RISE	Higher temperatures	security of supply	4	1	4	Evaporation risks included in UKWIR CC assessments and in WRMP CC assessments	2	1	2	Assumes CC investment in WRMP delivered before 2035. Continue to review as part of rainfall runoff modelling improvements
WT5	WATER TREATMENT	Service Reservoirs & Water Towers	DROUGHT	Loss of / intermittent supply	increases risk of external contaminants entering supply pipelines	2	2	4	Routine SR cleaning and WTW operating at <1 NTU on final water in line with WQ requirements	2	1	2	Continue existing practices
WT7	WATER TREATMENT	Service Reservoirs & Water Towers	DROUGHT	Inversions occur more frequently with low water levels;	Cryptosporidium accumulation	4	1	4	Crypto removal at WTWs is nearly 100% already so low likelihood. SR cleaning	2	1	2	No additional action required
WR6	WATER RESOURCES	Raw water pipelines	DROUGHT	Lower flow rates	deposition; reduced raw water quality	2	1	2	Risk low due to flushing during increased flows	2	1	2	No action required
WR13	WATER RESOURCES	All Water Resources	FLOOD	Movement of permanent population (eg away from flood plains) and tourism due to flooding,	affecting supply-demand balance and other aspects	2	1	2	WRMP, Drought plan, Integrated Resource Zone, East -West link	2	1	2	No additional action required
WR14	WATER RESOURCES	Storage Reservoirs & Aqueducts	FLOOD	Increased soil erosion	siltation of dams, accelerating asset deterioration	2	1	2	Catchment management activities (SCAMP)	2	1	2	Continue SCAMP activities. Monitor siltation levels at dams periodically (bathymetry surveys 10 yr intervals)
WR16	WATER RESOURCES	All Water Resources	SEA LEVEL	Saline intrusion	accelerated asset deterioration	2	1	2	Sources at risk from saline intrusion are Dee and Lune.	2	1	2	Review risk with No.62
WR18	WATER RESOURCES	Boreholes / source pumping stations	SEA LEVEL	Saline intrusion	decreasing yields, causing reduction in security of supply	2	1	2	It is not anticpated that anymore of our Borehole sources will be impacted by saline intrusion	2	1	2	No further actions with 0.15m SLR
WR21	WATER RESOURCES	All Water Resources	TEMP. RISE	Higher average and peak temperatures	accelerated deterioration of structures, buildings, machinery, equipment	2	1	2	British building standardsshould address these issues given small temperature increases predicted by 2035	2	1	2	No further action required as work to British Standards
WR22	WATER RESOURCES	All Water Resources	TEMP. RISE	Redistribution of / increase in tourism	reduced security of supply	2	1	2	WRMP, Drought plan, Integrated Resource Zone, East -West link	2	1	2	Assumes investment in WRMP delivered. Continue to review tourist population forecasts in future WRMPs
WR26	WATER RESOURCES	Storage Reservoirs & Aqueducts	TEMP. RISE	Increased evapotranspiration,	lower infiltration and borehole yields, reducing security of supply	2	1	2	Evaporation risks included in UKWIR CC assessments and in WRMP CC assessments	2	1	2	Assumes CC investment in WRMP delivered before 2035. Continue to review as part of rainfall runoff modelling improvements
WT4	WATER TREATMENT	Service Reservoirs & Water Towers	DROUGHT	Intermittency in supply	silt and debris accumulating in service reservoirs and towers	2	1	2	Routine SR cleaning and WTW operating at <1 NTU on final water in line with WQ requirements	2	1	2	Continue existing practices

Water resources – treatment - network

						2035							
						Company's initial risk				Company's residual risk			
ID	ASSET LEVEL 2	ASSET LEVEL 3	CLIMATE VARIABLE	IMPACT	CONSEQUENCE FOR ASSETS & OPERATIONS	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Liklehood)	Detail of adaptation actions already being undertaken	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Liklehood)	Proposed action to mitigate residual risk
WT6	WATER TREATMENT	Service Reservoirs & Water Towers	DROUGHT	Loss of supply and de-pressurisation	more frequent pipe failure	2	1	2	No specific actions	2	1	2	No additional action required
WT13	WATER TREATMENT	All Water Treatment	SEA LEVEL	Sea level rise	increases frequency of power loss	2	1	2	No actions as no assets are sufficiently close to the sea to be affected	2	1	2	No further actions
WT16	WATER TREATMENT	All Water Treatment	SEA LEVEL	Saline intrusion in groundwater	accelerated asset deterioration	2	1	2	It is not anticpated that anymore of our Borehole sources will be impacted by saline	2	1	2	No further actions with 0.15m SLR
WT18	WATER TREATMENT	All Water Treatment	TEMP. RISE	Higher average and peak temperatures	accelerated deterioration of structures, buildings, machinery, equipment	2	1	2	British building standardsshould address these issues given small temperature increases predicted by 2035	2	1	2	No further action required as work to British Standards
WN2	WATER NETWORKS	Distribution networks incl. ancillaries	DROUGHT	Loss of supply and depressurisation of the supply network,	more frequent pipe failure	2	1	2	We have plastic pipes across the network and undertake leakage detection. Activities can be heightened when required.	2	1	2	Nothing further required if WTWs and pumping stations addressed
WN3	WATER NETWORKS	Distribution networks incl. ancillaries	DROUGHT	Loss of / intermittent supply	increases risk of mechanical asset failure (eg in PRVs)	2	1	2	Current operation of assets considered sufficent	2	1	2	Nothing further required if WTWs and pumping stations addressed
WN4	WATER NETWORKS	Distribution pumping stations	DROUGHT	Loss of supply and depressurisation of the supply network,	more air blockages and service failure	2	1	2	No specific actions to date	2	1	2	Consider CC assessed source reliable yields in designing minimum throughput of all new/refurbished pumping stations and include variable speed pumps at critical sites so can operate at low flows
WN6	WATER NETWORKS	Distribution storage	DROUGHT	Lower flow rates	deposition, reducing raw water quality	2	1	2	Routine SR cleaning and WTW operating at <1 NTU on final water in line with WQ requirements	2	1	2	No additional action required
WN7	WATER NETWORKS	Distribution storage	DROUGHT	Loss of supply or intermittent supplies	contamination from accumulated silt and debris being flushed out of service reservoirs and towers	2	1	2	Routine SR cleaning and WTW operating at <1 NTU on final water in line with WQ requirements	2	1	2	No additional action required
WN11	WATER NETWORKS	Distribution networks incl. ancillaries	FLOOD	Direct flooding	contaminants enter pipelines	2	1	2	Low risk as pipe materials have degree of resistance and most are underground	2	1	2	No action required
WN12	WATER NETWORKS	Distribution storage	FLOOD	Direct flooding	contaminants enter underground storage tanks	2	1	2	Few underground tanks - most are SRs (see 38)	2	1	2	No action required
WN14	WATER NETWORKS	All Water Networks	TEMP. RISE	Higher average and peak temperatures	accelerated deterioration of structures, buildings, machinery, equipment	2	1	2	British building standardsshould address these issues given small temperature increases predicted by 2035	2	1	2	No further action required as work to British Standards

A.2 WASTEWATER SERVICE

Wastewater - network

ID	ASSET LEVEL 3	CLIMATE VARIABLE	DESCRIPTION	PRIMARY IMPACT OF CLIMATE VARIABLE	POTENTIAL IMPACTS ON ORGANISATION AND STAKEHOLDERS	2035							
						Company's initial risk				Company's residual risk			
						Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Liklehood)	Detail of adaptation actions already being undertaken	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Liklehood)	Proposed action to mitigate residual risk
WwN 1	Sewer networks, incl./trunk sewers	FLOOD	Increased volumes of storm water in combined sewers exceeds sewer capacity and causes **customer flooding**	Increased volumes of storm water	Customer flooding	6	4	24		6	4	24	short term - continue to build our way out long term - stop SW getting into our system &/or build new SW sewers
WwN 2	All wastewater networks	FLOOD	Direct asset flooding causes **service failure and asset loss**	Direct asset flooding	Asset loss and service failure	6	3	18		6	3	18	develop flood plans for assets
WwN 3	All wastewater networks	SEA LEVEL	Direct asset flooding, storm damage and coastal erosion or planned retreat cause **service failure** and **asset loss**	Direct asset flooding	Asset loss and service failure	6	3	18		6	3	18	develop flood plans for assets
WwN 4	CSOs and overflows	DROUGHT	Lower average and peak 'carry' flows lead to settlement in the system, with shock loads causing CSO **H&S risk** and **reduced receiving water quality**	Lower average and peak flows	blockage of PFF point and unconsented discharge	4	4	16	improved monitoring	4	4	16	better monitoring and planned intervention
WwN 5	Sewer networks, incl./trunk sewers	DROUGHT	Lower precipitation, infiltration & inflow and water conservation lead to lower average and peak 'carry' flows, resulting in greater sewer deposits and more frequent blockages, causing **customer flooding**	Lower precipitation, infiltration & inflow plus water conservation	More frequent sewer blockages and increased customer flooding	4	3	12	existing best practice work + what not to flush / bag it and bin it	4	3	12	do more and improve the targeting
WwN 6	CSOs and overflows	DROUGHT	Lower average and peak 'carry' flows lead to settlement in the system, with shock loads causing CSO **H&S risk** and **reduced receiving water quality**	Lower average and peak flows	Reduced receiving water quality and CSO new discharge consent from EA further spill reduction	4	3	12		4	3	12	SW removal may remove the need for the CSO
WwN 7	CSOs and overflows	FLOOD	Higher storm intensity means CSOs spill more frequently, **impacting on receiving water quality**	Higher storm intensity	Increased risk of failing spill frequency consent coastal	6	2	12		6	2	12	short term - continue to build our way out long term - stop SW getting into our system &/or build new SW sewers
WwN 8	Pumping stations	FLOOD	Increased volumes of storm water require increased pumping in combined sewer systems, causing **accelerated asset deterioration**	Increased volumes of storm water in combined sewers	Increased pump usage & accelerated asset deterioration	4	3	12		4	3	12	change design standards
WwN 11	Rising mains	DROUGHT	Lower average and peak 'carry' flows lead to H2S settlement in the system, causing **accelerated asset deterioration**	Lower average and peak flows	Accelerated asset deterioration	2	3	6		2	3	6	short term - more dosing long term - redesign PS

Wastewater - treatment

ID	ASSET LEVEL 3	CLIMATE VARIABLE	DESCRIPTION	PRIMARY IMPACT OF CLIMATE VARIABLE	POTENTIAL IMPACTS ON ORGANISATION AND STAKEHOLDERS	2035							
						Company's initial risk				Company's residual risk			
						Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Likelihood)	Detail of adaptation actions already being undertaken	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Likelihood)	Proposed action to mitigate residual risk
WwT 1	All Wastewater treatment	FLOOD	Increased storm frequency and power supply flooding increases frequency of power loss.	Process loss and potential flooding - service failure	Power outages and service failure	6	4	24		6	4	24	id locations with power supplier and dvelop action plan
WwT 2	All Wastewater treatment	FLOOD	Direct asset flooding.	Asset loss and service failure	Asset loss and service failure	6	3	18	flood risk plans for PPC sites only	6	3	18	flood plans for all sites outputs feed into catchment planning process
WwT 3	Treatment works	DROUGHT	Lower river flows.	New consents from EA	Reduced water quality, increased risk of a consent failure / pollution incident	6	3	18	icm - sustainable catchment work. more likely to support the need for consent change than help adapt to it	6	3	18	Work with EA to ensure that the most suatainable outcomes are achieved.
WwT 4	Treatment works	DROUGHT	Lower average and peak flows increasing need for recirculation pumping	Increased need for recirculation pumping	Increased need for recirculation pumping	4	3	12		4	3	12	SHORT TERM - change the flow pattern at the WwTW LONG TERM - Change asset design standard to remove the need for recirculation.
WwT 5	Treatment works	DROUGHT	Lower average and peak 'carry' flows lead to settlement in the system, with shock loads.	Shock loading resulting in increased asset deterioration	Accelerated asset deterioration and H&S risk	4	3	12		4	3	12	Change asset design standard to cope with this mode of operation
WwT 6	Treatment works	TEMP. RISE	Increased septicity levels and odour.	Greater septicity and odour		4	3	12		4	3	12	odour management plans
WwT 7	All Wastewater treatment	DROUGHT	Changes in domestic waste disposal patterns lead to changes in dry weather flow pollutants, **affecting treatment process.**	Reduced dry weather flow and change in domestic waste disposal change in the use /operation of assets more conentrated waste	Affects treatment processes	2	4	8		2	4	8	Pick up national R&D work on this issue
WwT 8	Treatment works	FLOOD	Extended duration of FFT due to increased rainfall and/or storage return.	Accelerated asset deterioration and failure	Accelerated asset deterioration and failure	2	4	8	Removal of SW from system through SUDS - supply /demand controls	2	4	8	Assess the need to change asset design standard to cope with this mode of operation
WwT 9	Treatment works	FLOOD	Longer retention of water in storm tanks leads to increased septicity and operational problems.	Reduction in process performance efficiency leading to odour problems	Reduction in process performance efficiency leading to odour problems	2	3	6		2	3	6	odour management plans and need to change asset design standards
WwT 10	Treatment works	DROUGHT	Lower average and peak 'carry' flows increases retention times and septicity / odour problems.	Increased septicity / odour problems	Increased septicity / odour problems	2	3	6	odour management plans	3	2	6	odour management plans
WwT 11	All Wastewater treatment	SEA LEVEL	Direct asset flooding.	Asset loss and service failure	Asset loss and service failure	6	1	6		6	1	6	Ensure asset design standard takes account of sea level rise
WwT 12	Outfalls	FLOOD	Higher peak levels and flows at discharges	Increased need for over pumping	Service failure	2	2	4		2	2	4	R&D project to id the most suatainable solution (storage - overpumping etc)

Wastewater - treatment

ID	ASSET LEVEL 3	CLIMATE VARIABLE	DESCRIPTION	PRIMARY IMPACT OF CLIMATE VARIABLE	POTENTIAL IMPACTS ON ORGANISATION AND STAKEHOLDERS	2035							
						Company's initial risk				Company's residual risk			
						Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Liklehood)	Detail of adaptation actions already being undertaken	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Liklehood)	Proposed action to mitigate residual risk
WwT 13	Treatment works	FLOOD	Dilution of, and rapid variations in, influent flows **affects process performance efficiency**	More dilution / variability in influent flows	Reduction in process performance efficiency	2	2	4	piston effect study	2	2	4	
WwT 14	Treatment works	SEA LEVEL	Saline intrusion	Influent more difficult to treat and potential increased asset deterioration	Accelarated asset deterioration	2	1	2		2	1	2	

Wastewater - sludge

						2035							
						Company's initial risk				Company's residual risk			
ID	ASSET LEVEL 3	CLIMATE VARIABLE	DESCRIPTION	PRIMARY IMPACT OF CLIMATE VARIABLE	POTENTIAL IMPACTS ON ORGANISATION AND STAKEHOLDERS	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Likelihood)	Detail of adaptation actions already being undertaken	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Likelihood)	Proposed action to mitigate residual risk
WwS 1	All Sludge	FLOOD	Direct asset flooding	Asset loss and service failure	Asset loss and service failure	6	3	18	flood risk plans for PPC sites only	6	3	18	flood plans for all sites outputs feed into catchment planning process
WwS 2	Sludge disposal or re-cycling	FLOOD	Flooding / saturated ground prevents access to fields	Loss of disposal route	Service failure	6	3	18	Increased capacity at incineration plant	4	3	12	Procuce detailed action plan identifying other disposal routes or actions
WwS 3	Sludge disposal or re-cycling	FLOOD	Flooding cuts sludge transport routes causing **service failure**	Flooding of sludge transport routes	Service failure	2	2	4		2	2	4	Produce plan identifying alternative routes

A.3 SUPPORT SERVICES

Support services

						2035							
						Company's initial risk				Company's residual risk			
ID	ASSET LEVEL 3	CLIMATE VARIABLE	DESCRIPTION	PRIMARY IMPACT OF CLIMATE VARIABLE	POTENTIAL IMPACTS ON ORGANISATION AND STAKEHOLDERS	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Liklehood)	Detail of adaptation actions already being undertaken	Level of consequence (2 - 8)	Level of likelihood (1 - 4)	Level of risk (Consequence X Liklehood)	Proposed action to mitigate residual risk
SS 1	**CIO**		Impact on communication links	telemetry / control links inoperable		6	3	18	work already underway to improve the resilience of comms links	4	2	8	Continue to review the need for further work
SS 2			Staff unable to travel to UU sites	increased remote/home working and increased pressure on comms links		4	4	16	work already underway to improve the resilience and capacity of comms links	2	2	4	Continue to review the need for further work
SS 3	**Supply chain**		suppliers unware of CC related risks			4	3	12		4	3	12	Working with suppliers to help them adapt to CC impacts
SS 4			increased energy costs as a result of increased pumping			2	2	4	already working with energy supllliers to ensure lowest costs	2	2	4	Continue to review the need for further work
SS 5			impact may be worse in different regions or countries			2	2	4	business continuity work sustainability work with suppliers	2	1	2	Continue to review the need for further work
SS 6	**Legal**		increase in our insurance premiums as a result of increase in claims			4	4	16		4	4	16	Review the type and number of claims to see if work is required to remove/reduce the risk
SS 7	**Investor Relations**		water trading / competition			2	2	4		2	2	4	work with Ofwat to ensure that competition takes account of CC and the need to adapt
SS 8	**HR**		availability of resource during extreme events			4	3	12		4	3	12	Identify lessons to be learnt and act on them work with partners to identify additional resource
SS 9			impact of heatwave on staff			4	3	12		4	3	12	Pickup NHS work and act on results Continue to monitor and implement the guidelines on staff H&S
SS 10	**Property**		risk of flooding to office buildings			4	3	12		4	3	12	Enhance work already done for core water / wastewater assets to cover all buildings
SS 11			existing building not fit for future climate			2	2	4		2	2	4	Look at retrofit options new build property built to appropriate standards

APPENDIX B. CLIMATE CHANGE PROJECTIONS CONSIDERED IN OUR REPORT

Climate projection data used in all workshops.

Climate Change Adaptation Report

UKCP09 projections

Brian Morrow

Climate Change Adaptation Manager

Climate Change - UKCP09

- What is it?
  - Trends
    - Temperature
    - Precipitation
    - Sea level
  - Predictions
    - Temperature
    - Precipitation
    - Sea level rise

1

Climate Change - UKCP09
What is it ?

- UK Climate Impacts Programme produces scenarios of how the UK climate will change in the next 100 years
- UKCP09 is the latest scenario and contains info on the following areas -
    - Briefing
    - Trends
    - Climate Change (Land)
    - Marine & Coastal Projections
    - Weather Generator
    - Pre-prepared Maps & Graphs
- Change from previous scenarios
    - This one is probabilistic based

2

Climate Change - UKCP09

Trends

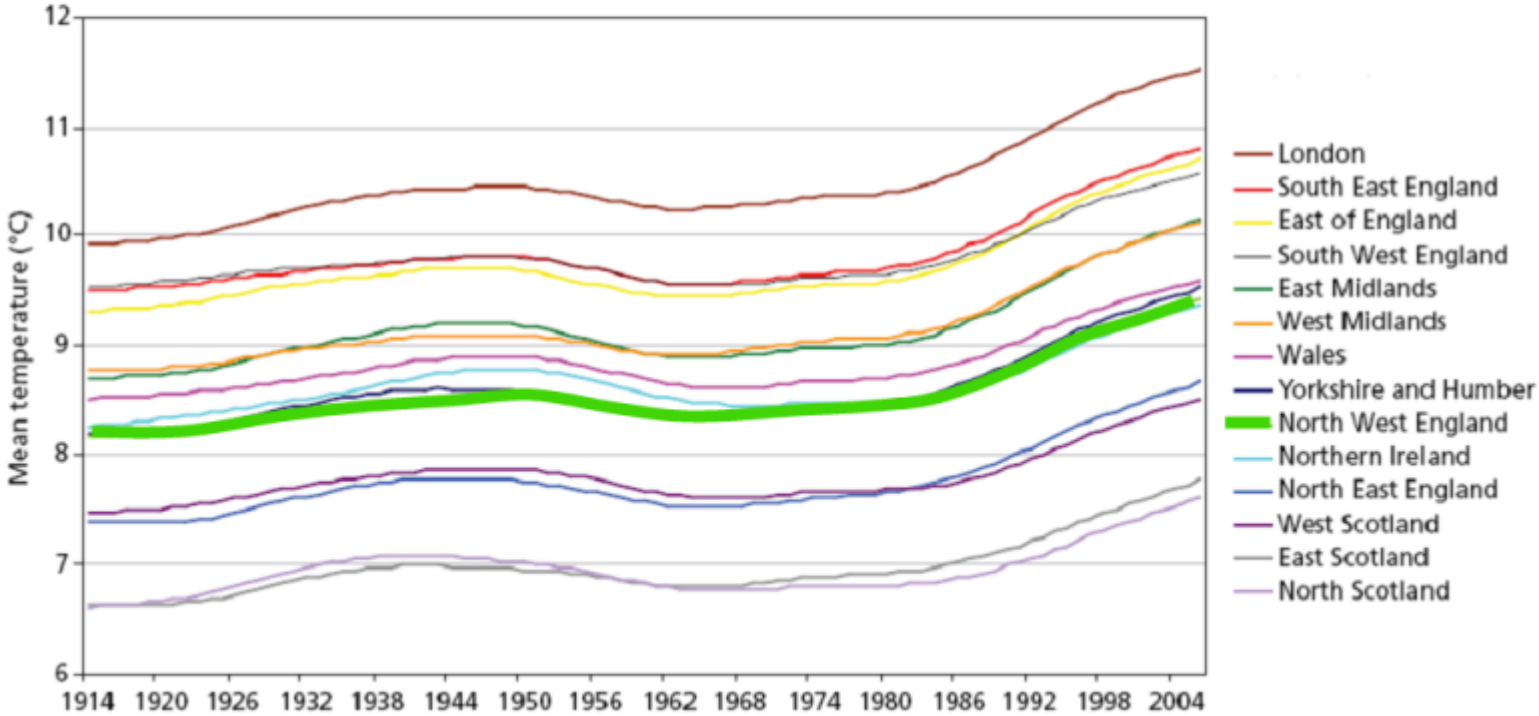
- Climate Change is not a new thing
- It's the rate of change that is new
- The Trends report (revised Jan 2009)
  - Describes the recent changes in UK climate as seen from observations

3

Climate Change - UKCP09

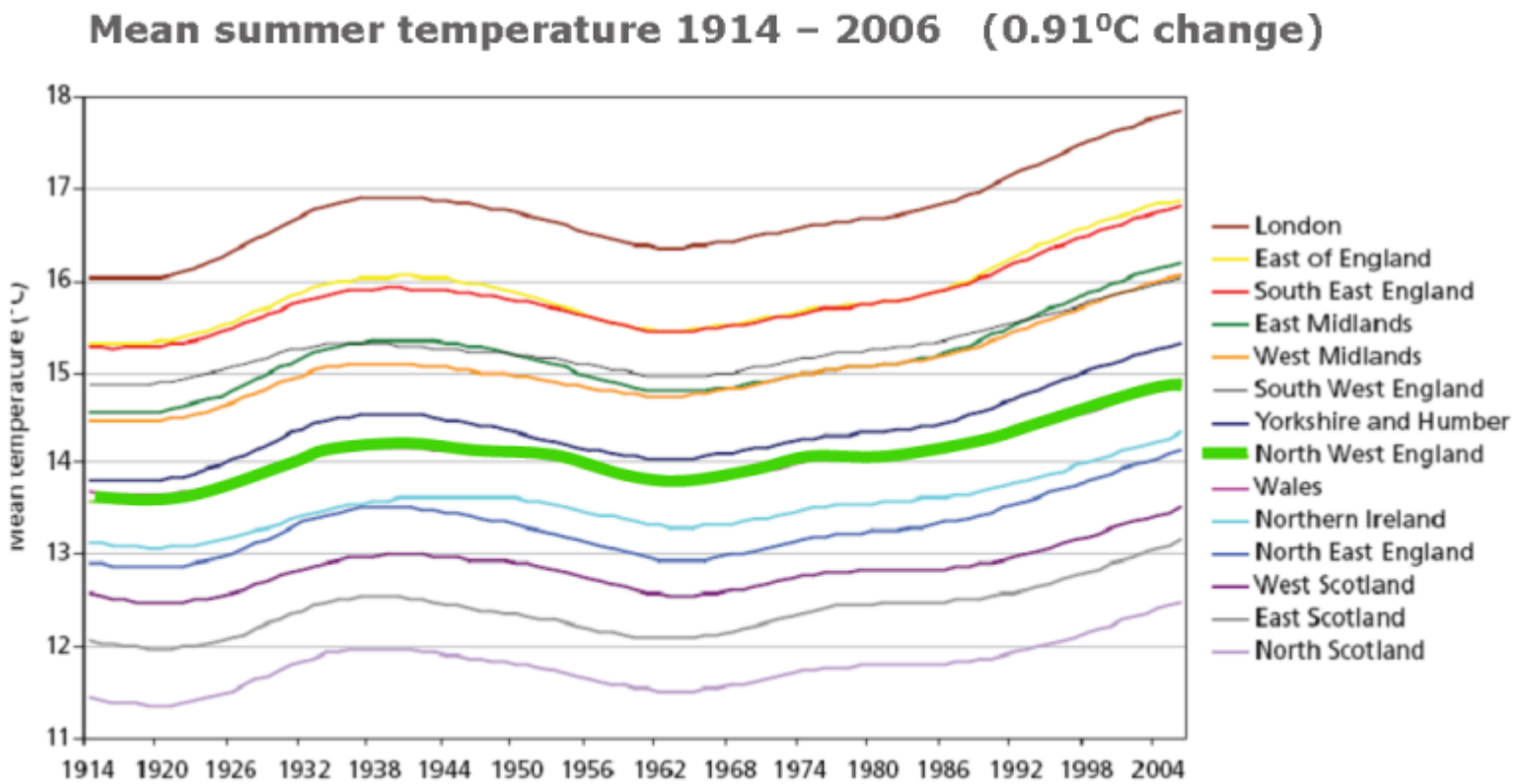
Trends - temperature

Mean annual temperature 1914 – 2006 (0.88^{0}C change)



Climate Change - UKCP09

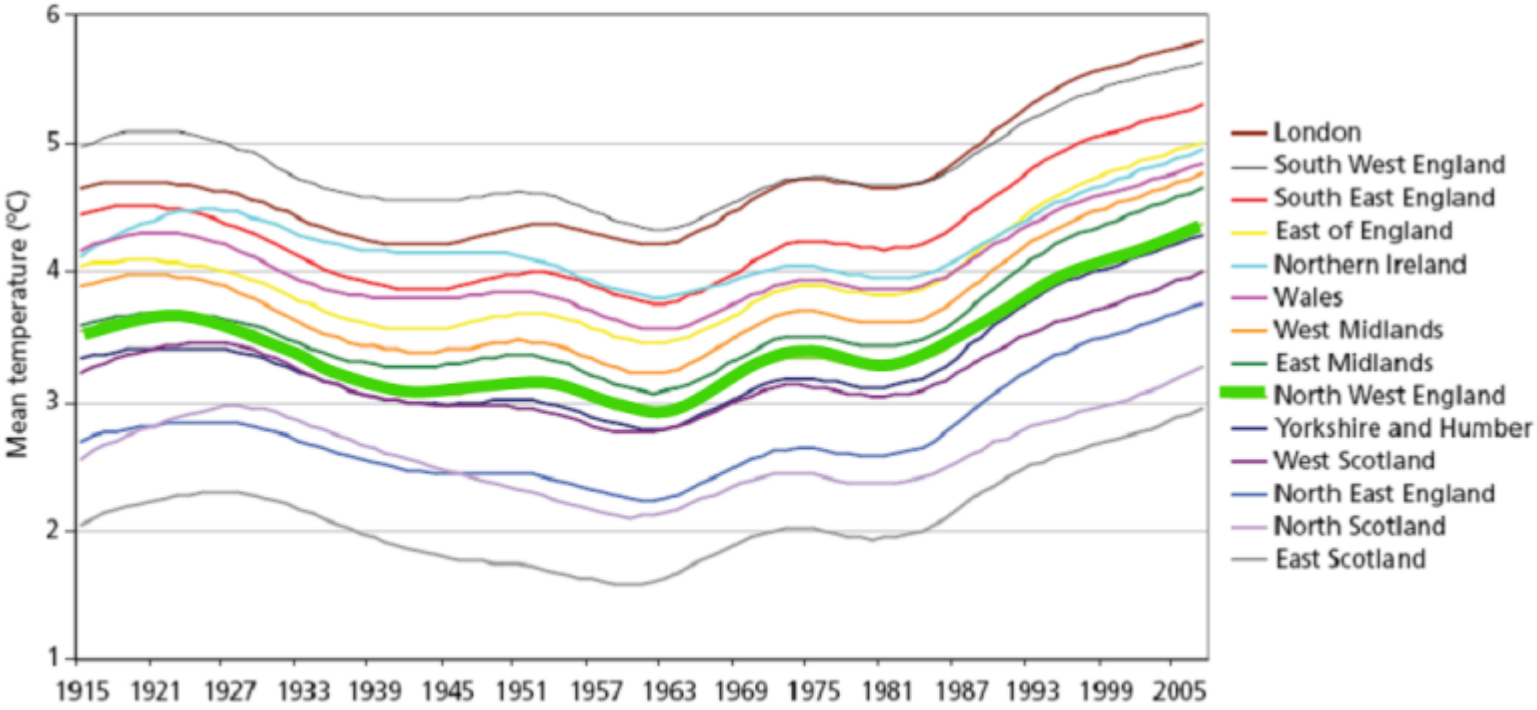
Trends - temperature



Climate Change - UKCP09

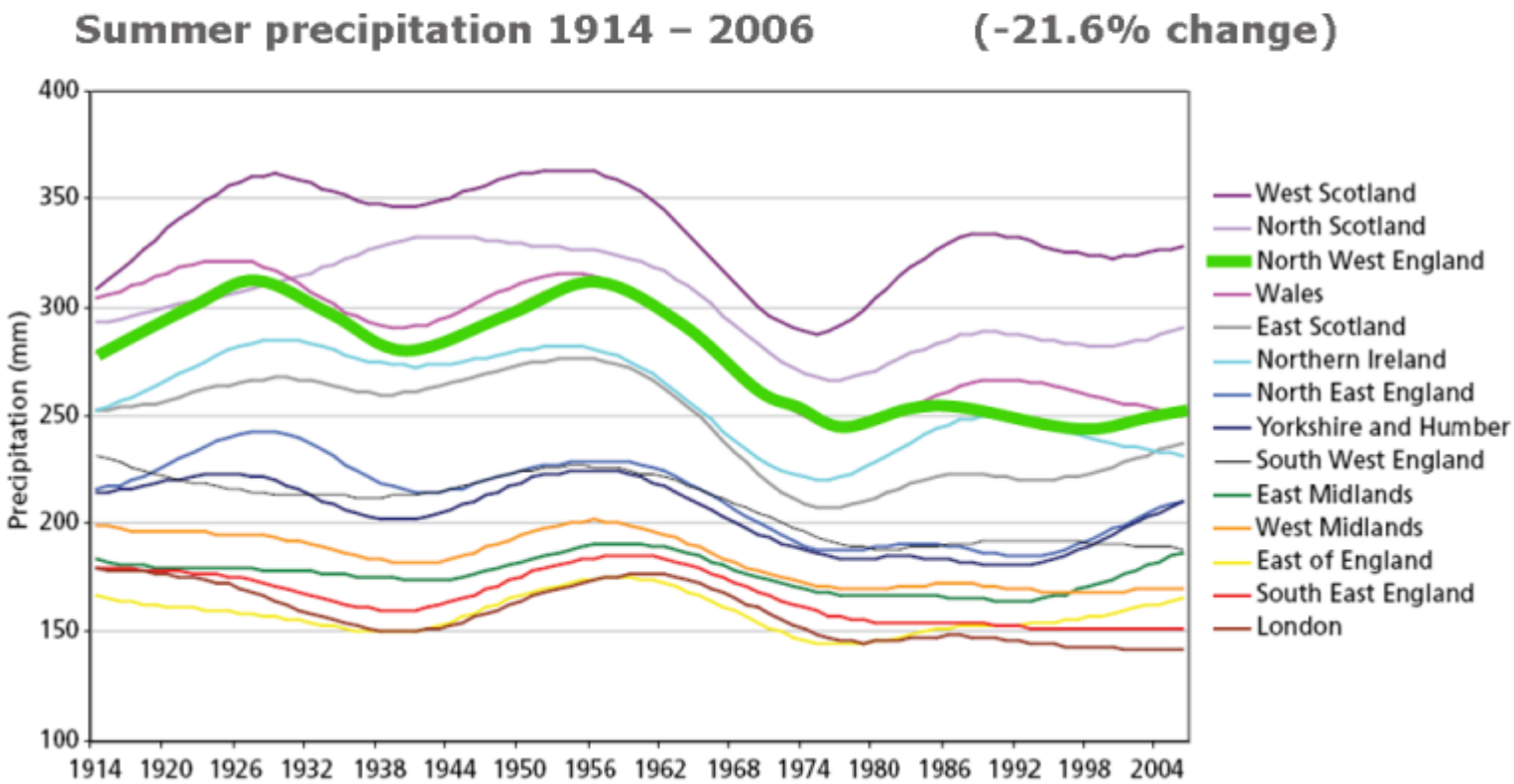
Trends - temperature

Mean winter temperature 1914 – 2006 (0.66⁰C change)



Climate Change - UKCP09

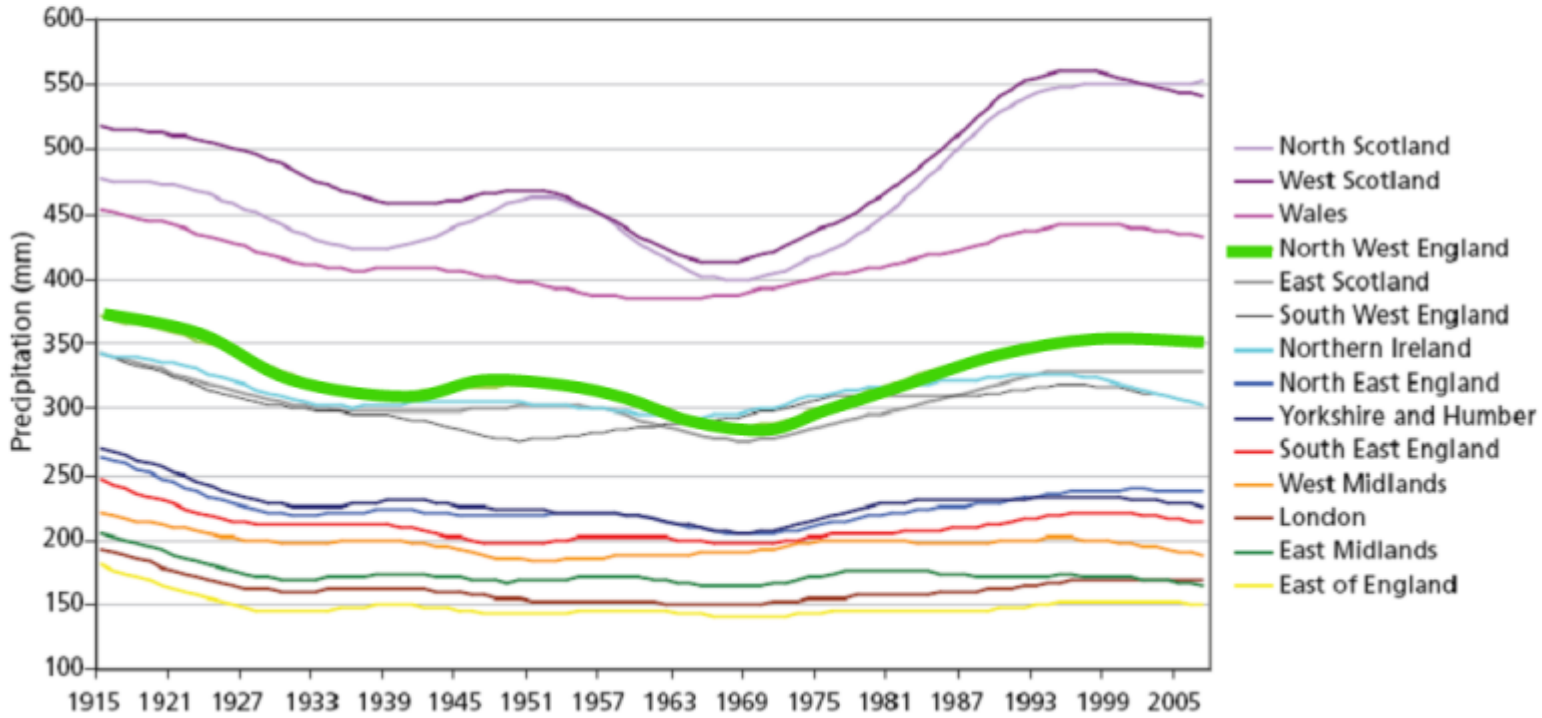
Trends - precipitation



Climate Change - UKCP09

Trends - precipitation

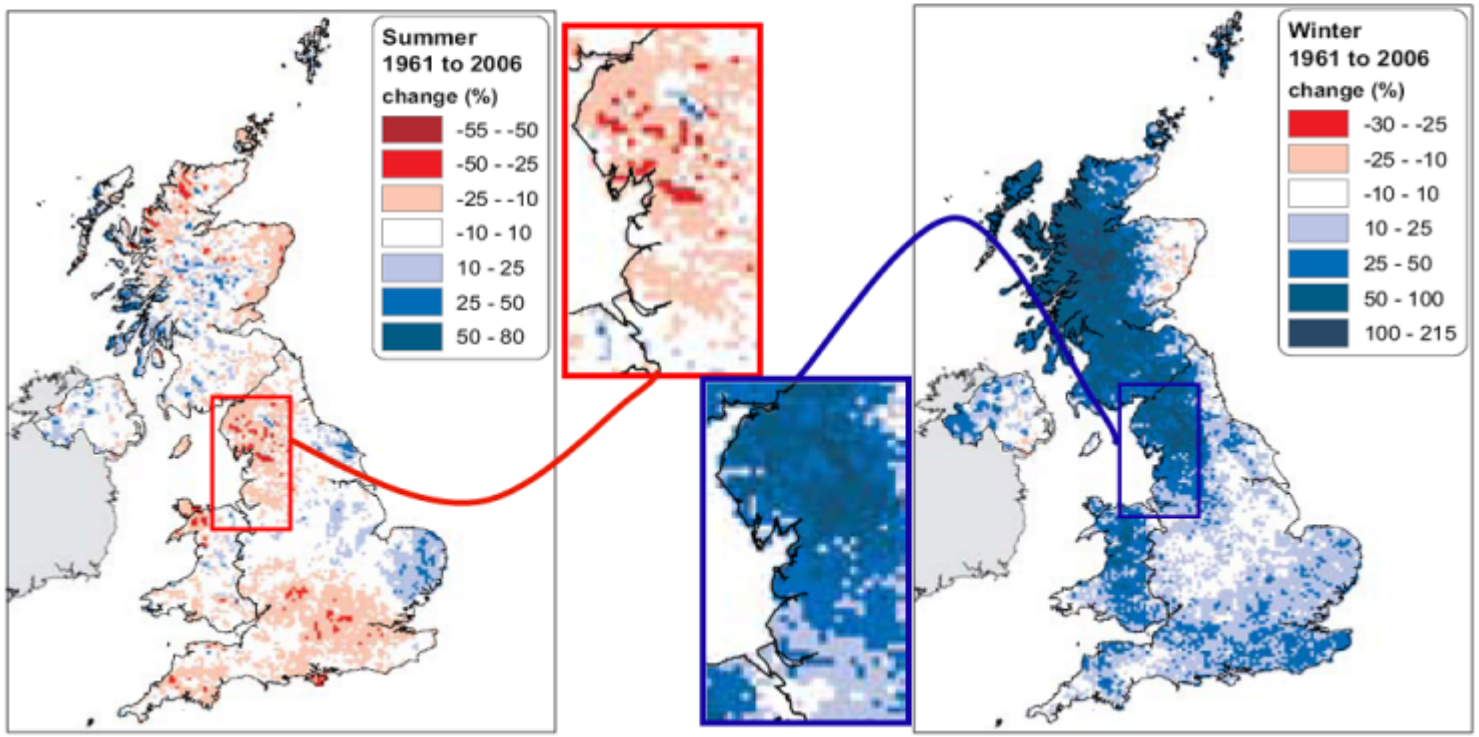
Winter precipitation 1914 – 2006 (-0.5% change)



Climate Change - UKCP09

Trends - precipitation

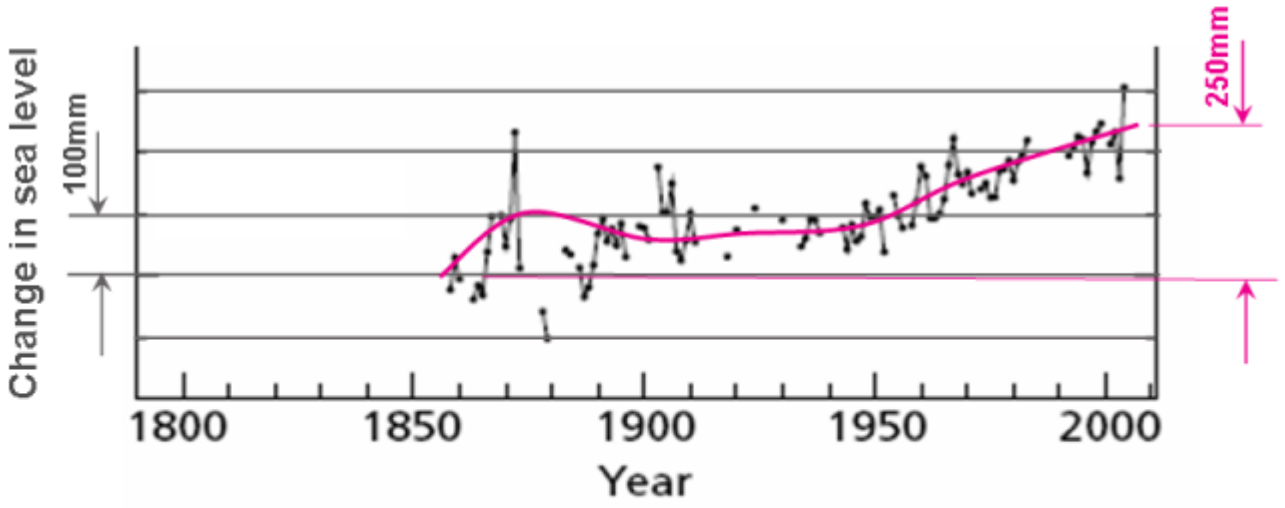
%age change in total precipitation 1961 – 2006



Climate Change - UKCP09

Trends – sea level

Liverpool Annual mean sea level



10

Climate Change - UKCP09

Predictions

Based on :

- **3 different emissions scenarios**

(These are plausible future pathways of emissions of greenhouse gases and other pollutants which can affect climate)

  - Low
  - Medium
  - **High**

All the following data is based on

- **Probabilistic based results**

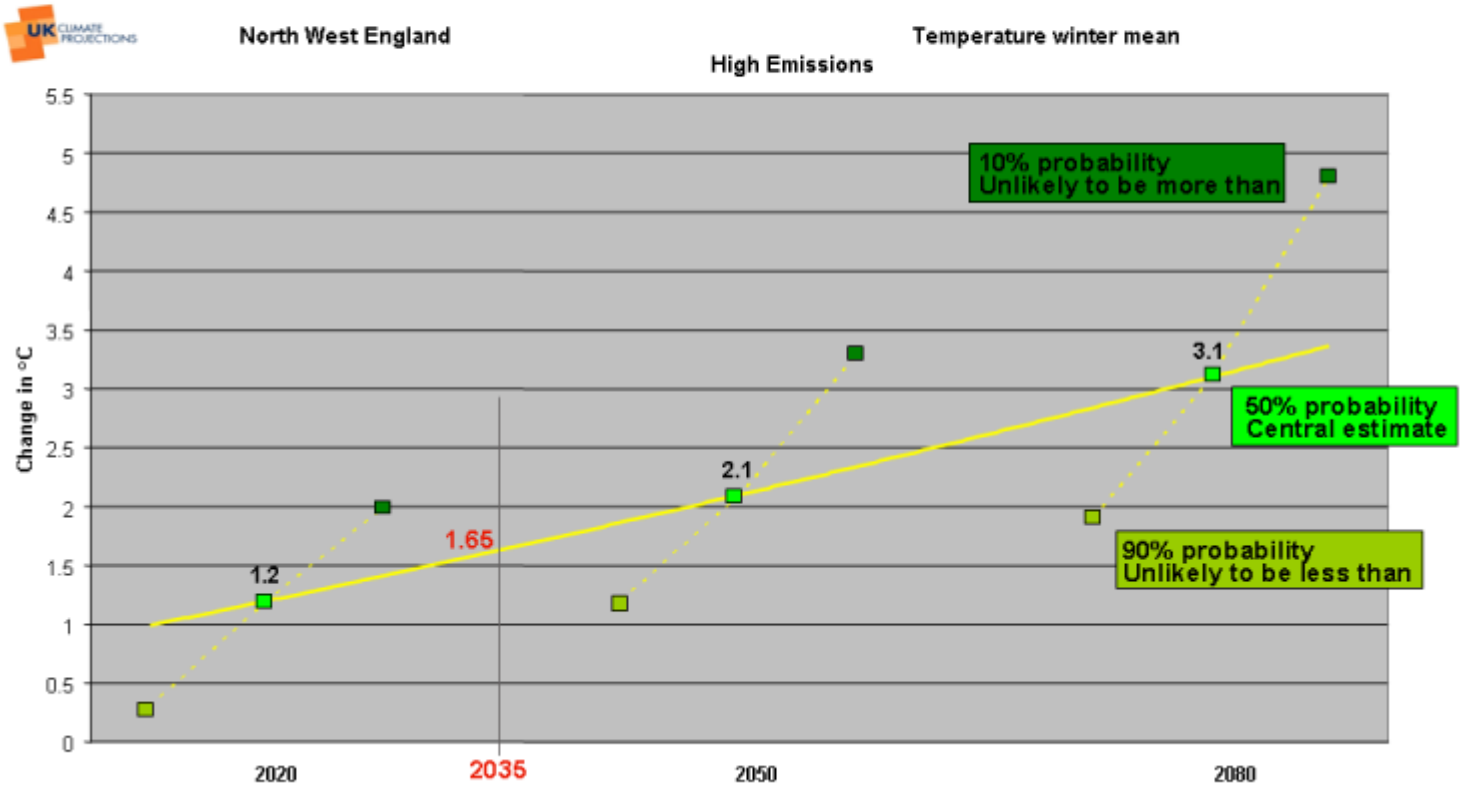
(Achieved by running numerous models with different start-up points and settings)

  - 10% (Unlikely to be more than)
  - **50% (Central estimate)**
  - 90% (Unlikely to be less than)

11

Climate Change - UKCP09

Predictions – winter mean temperature



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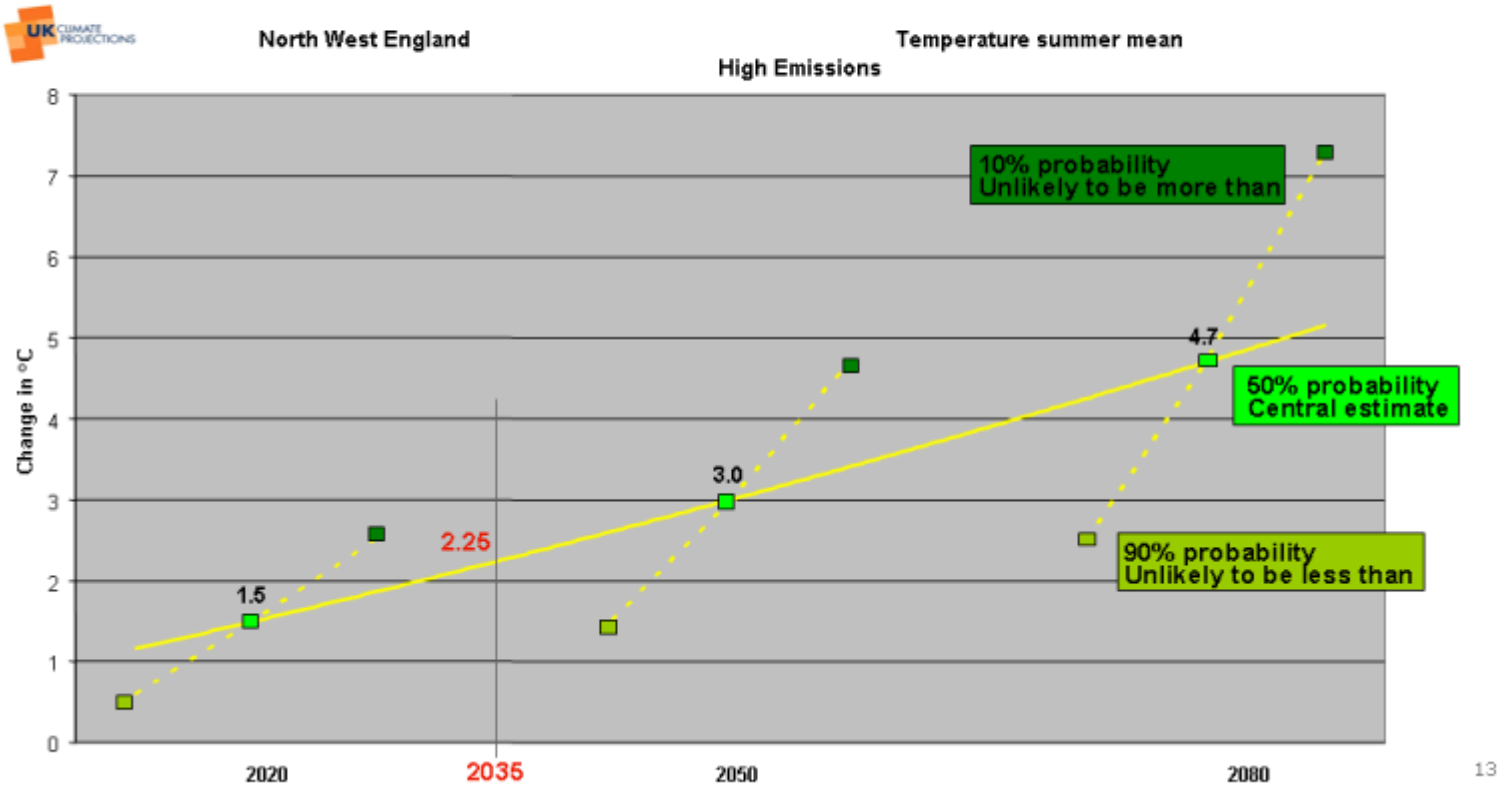
Climate Change - UKCP09

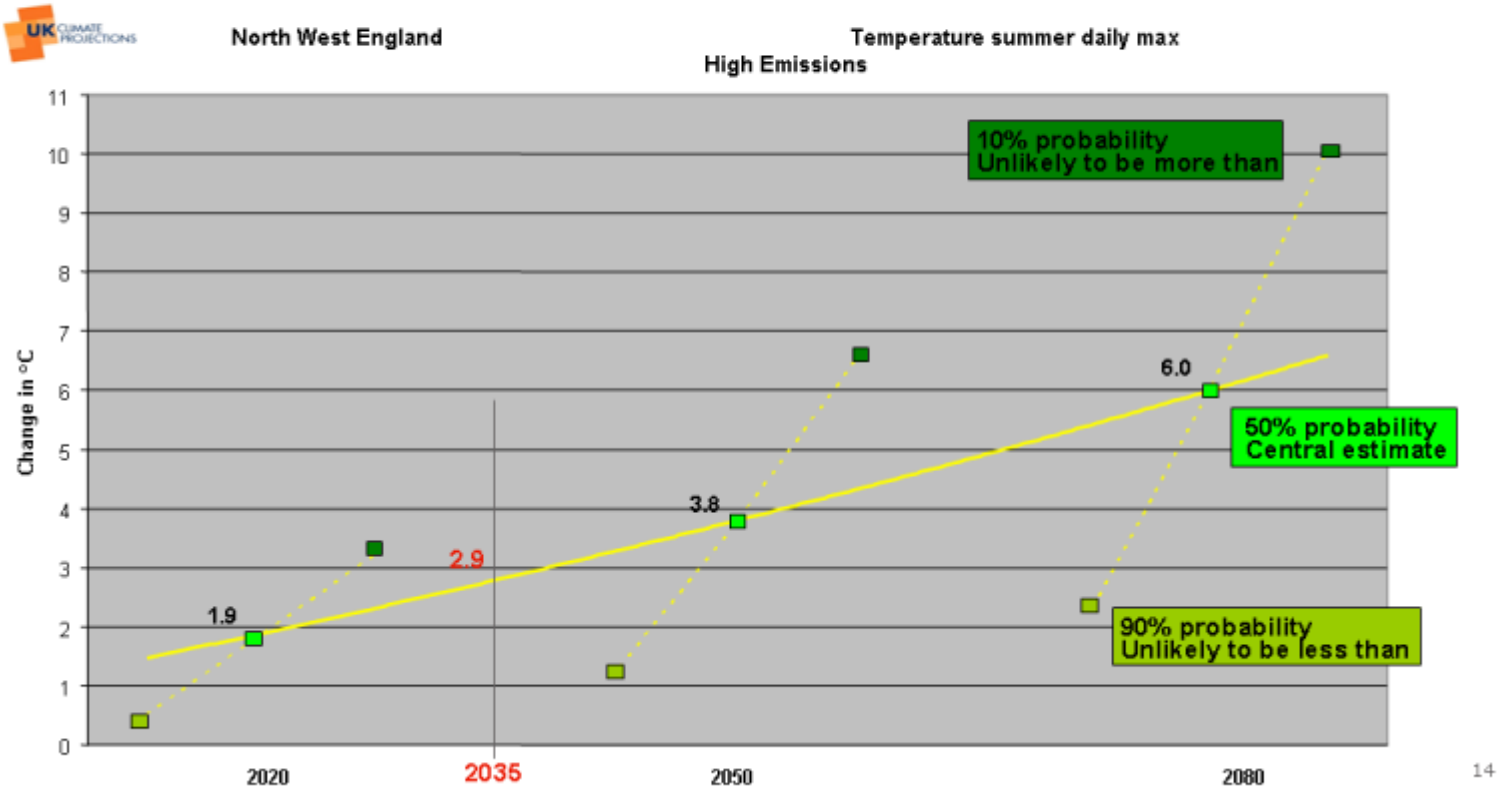
Predictions – summer mean temperature



13

Climate Change - UKCP09

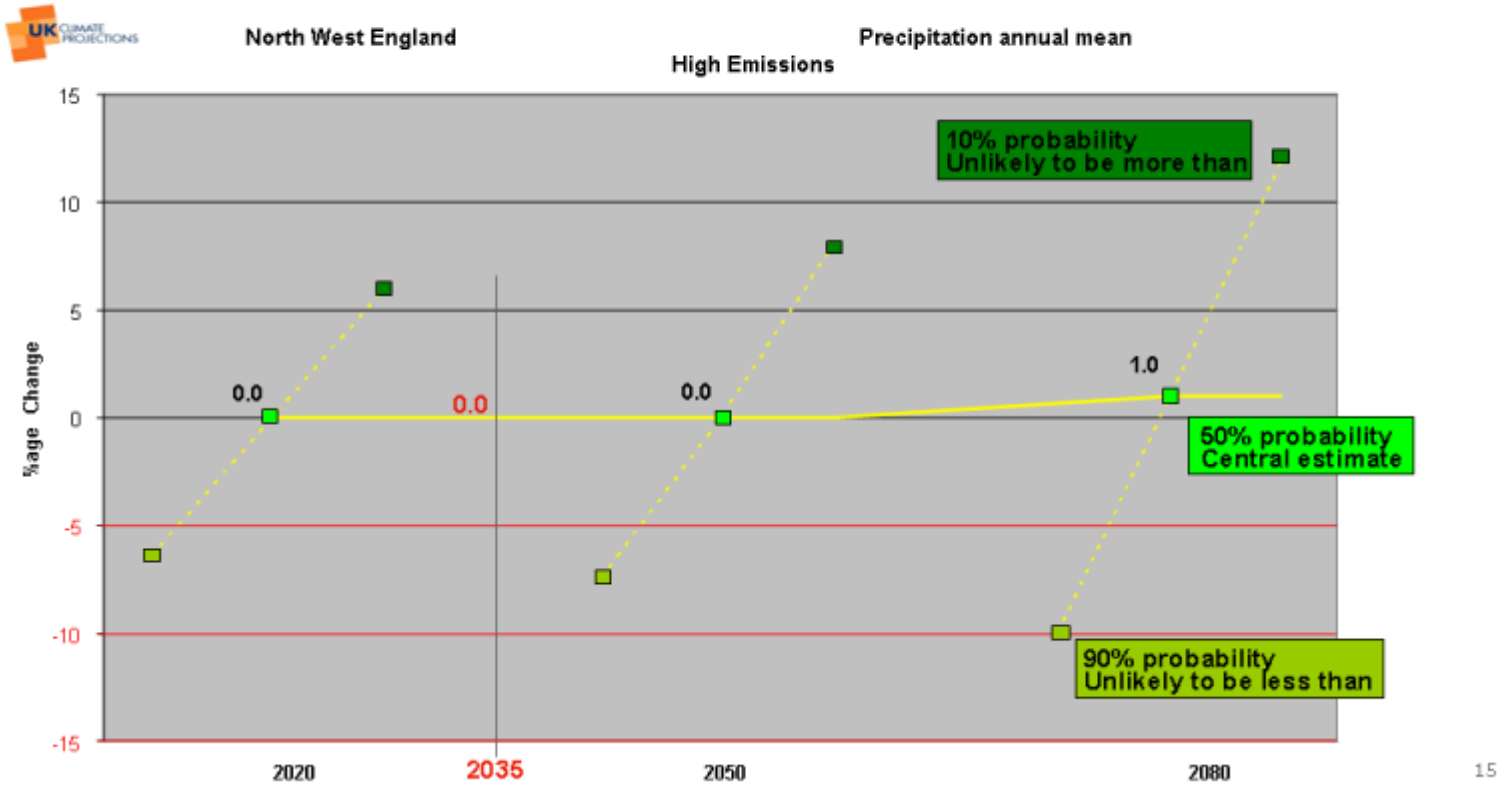
Predictions – summer daily max. temperature



14

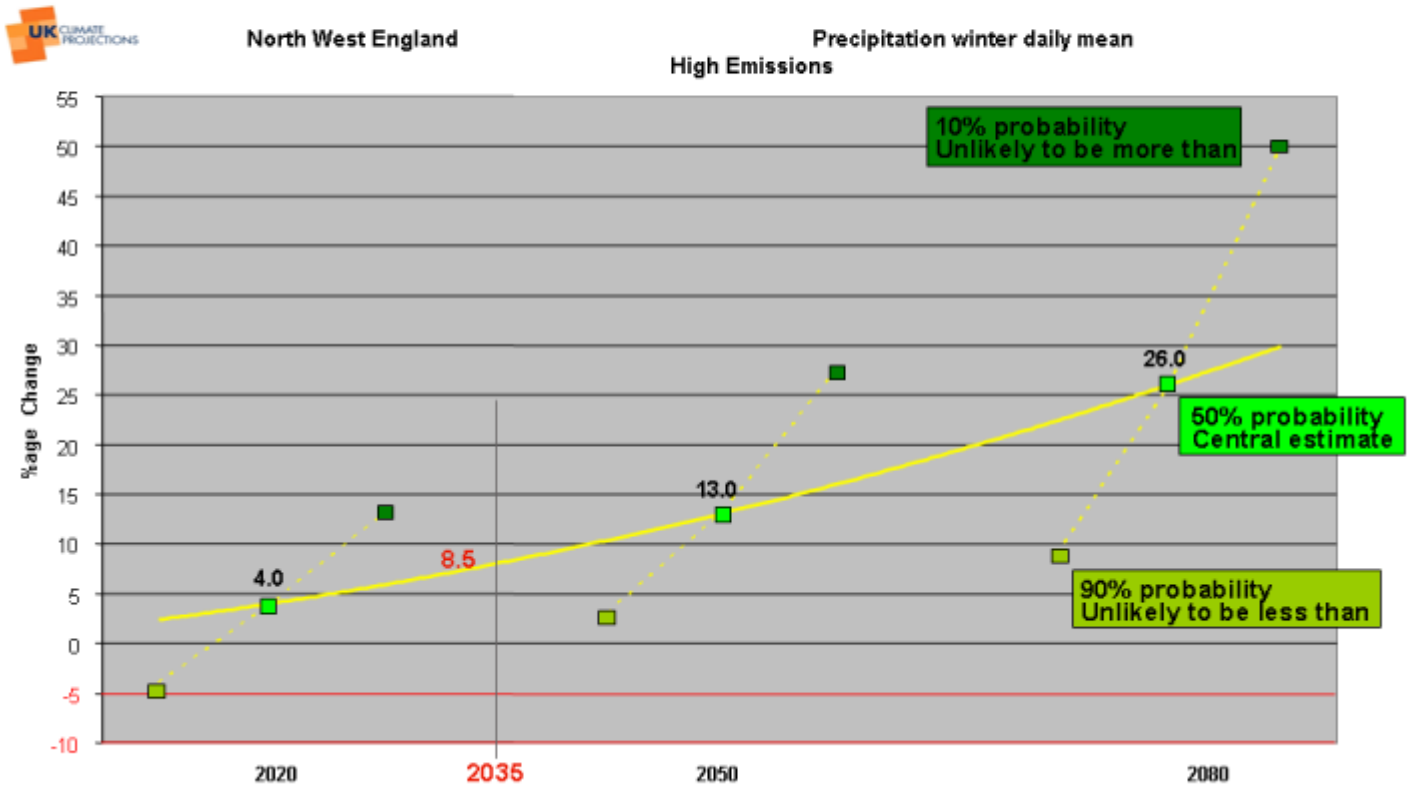
Climate Change - UKCP09

Predictions – annual precipitation



Climate Change - UKCP09

Predictions – winter precipitation



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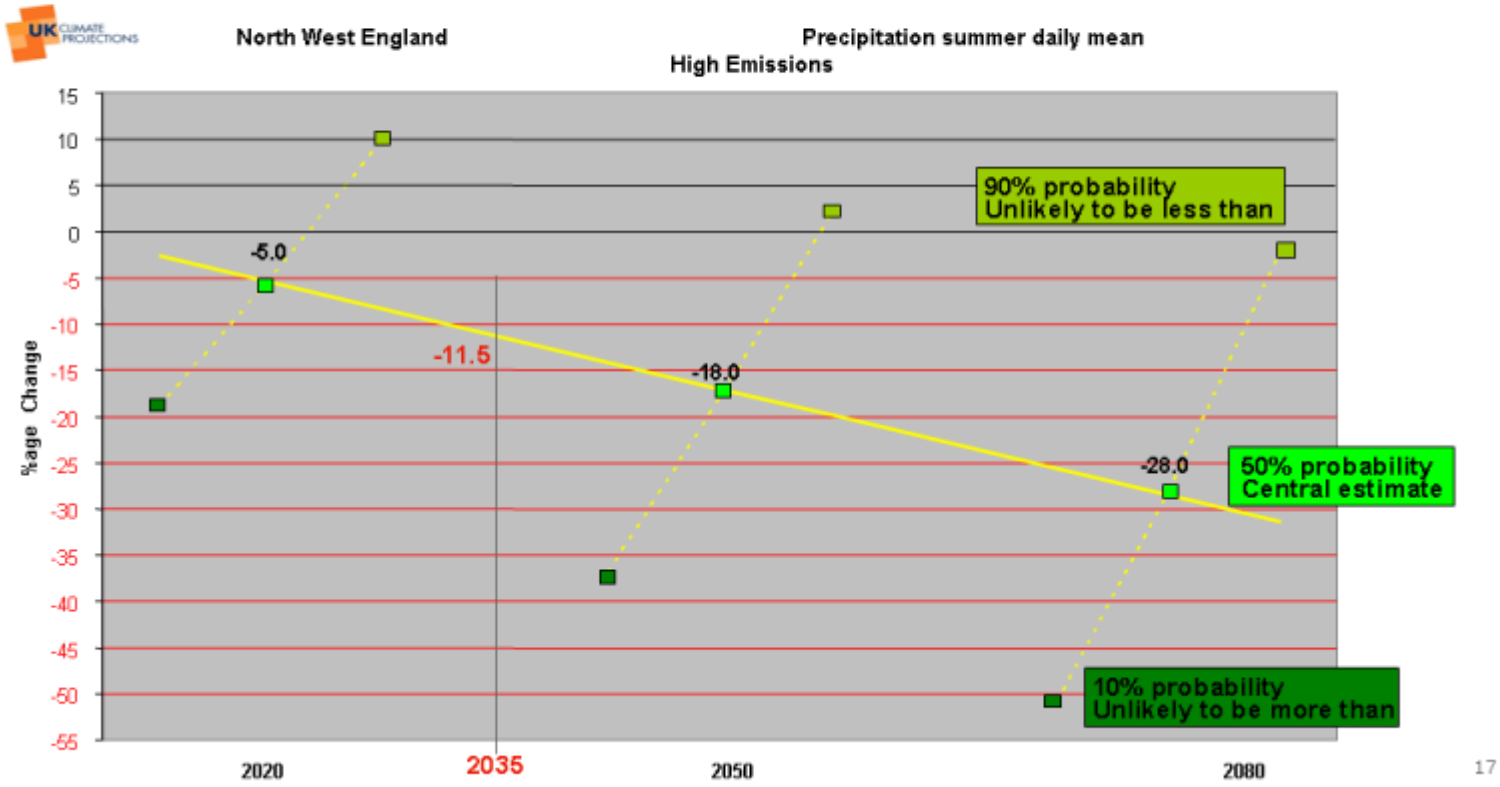
Climate Change - UKCP09

Predictions – summer precipitation



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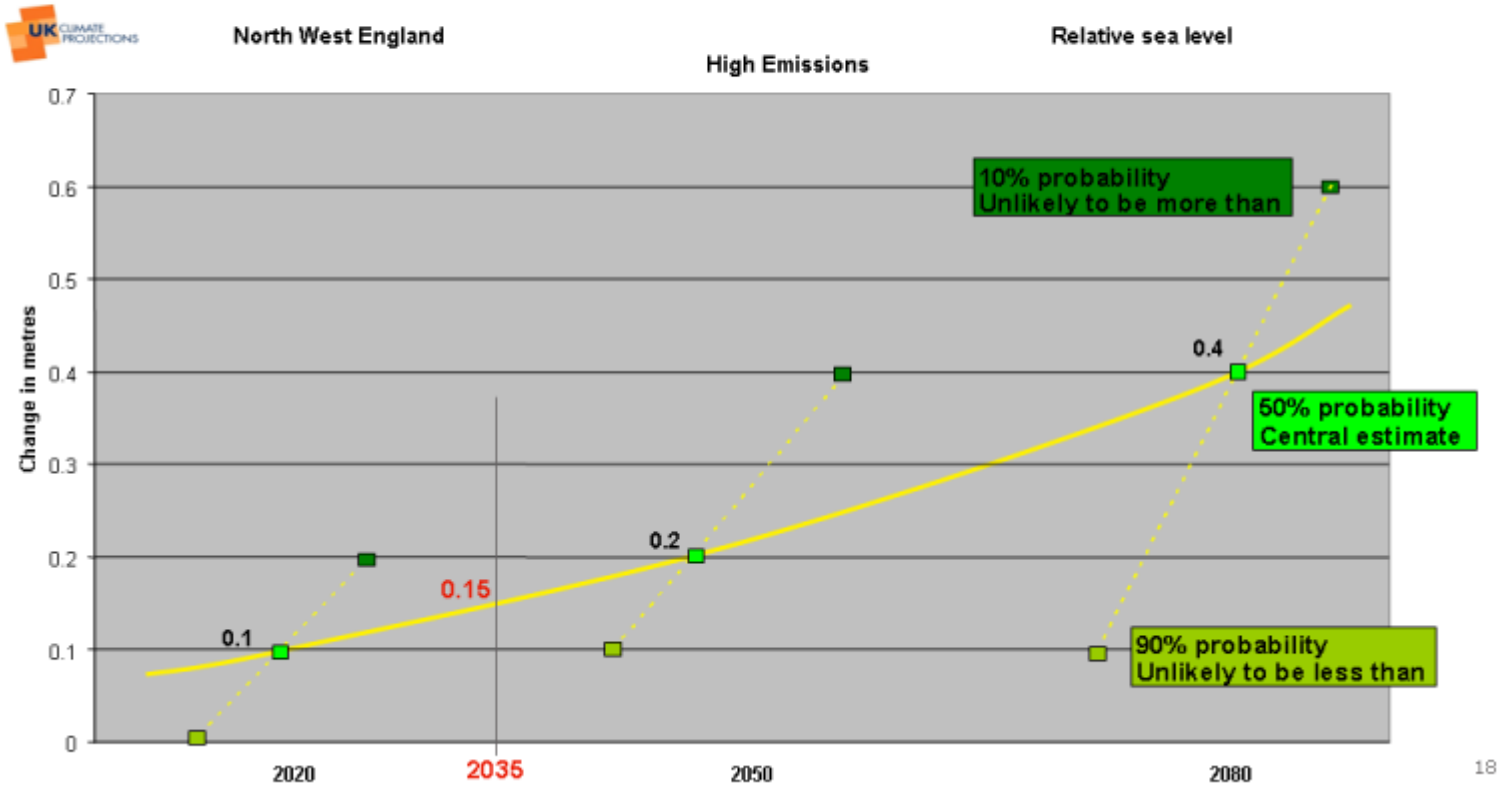
Climate Change - UKCP09

Predictions – sea level



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Climate Change - UKCP09

Predictions – Key findings for NW England 2020s

High emissions scenario – central estimate

Temperature

Increase in winter mean temperature is 1.2°C

it is very unlikely to be less than 0.3°C and is very unlikely to be more than 2°C.

Increase in summer mean temperature is 1.5°C

it is very unlikely to be less than 0.6°C and is very unlikely to be more than 2.5°C.

Increase in summer mean daily maximum temperature is 1.9°C

it is very unlikely to be less than 0.5°C and is very unlikely to be more than 3.3°C.

Precipitation

Change in annual mean precipitation is 0%

it is very unlikely to be less than –6% and is very unlikely to be more than 6%.

Change in winter mean precipitation is 4%

it is very unlikely to be less than –4% and is very unlikely to be more than 13%.

Change in summer mean precipitation is –5%

it is very unlikely to be less than –19% and is very unlikely to be more than 10%.

Sea Level

Change in relative sea level is 0.1m

it is very unlikely to be less than 0m and is very unlikely to be more than 0.2m

19

Climate Change - UKCP09

Predictions – Key findings for NW England 2035

High emissions scenario – central estimate

Temperature

Increase in winter mean temperature is 1.65°C

Increase in summer mean temperature is 2.25°C

Increase in summer mean daily maximum temperature is 2.9°C

Precipitation

Change in annual mean precipitation is 0%

Change in winter mean precipitation is 8.5%

Change in summer mean precipitation is –11.5%

Sea Level

Change in relative sea level is 0.15m

20

Climate Change - UKCP09

Predictions – Key findings for NW England 2050s

High emissions scenario – central estimate

Temperature

Increase in winter mean temperature is 2.1°C

it is very unlikely to be less than 1.2°C and is very unlikely to be more than 3.3°C.

Increase in summer mean temperature is 3°C

it is very unlikely to be less than 1.5°C and is very unlikely to be more than 4.7°C.

Increase in summer mean daily maximum temperature is 3.8°C

it is very unlikely to be less than 1.3°C and is very unlikely to be more than 6.5°C.

Precipitation

Change in annual mean precipitation is 0%

it is very unlikely to be less than –7% and is very unlikely to be more than 8%.

Change in winter mean precipitation is 13%

it is very unlikely to be less than 3% and is very unlikely to be more than 27%.

Change in summer mean precipitation is –18%

it is very unlikely to be less than –37% and is very unlikely to be more than 2%.

Sea Level

Change in relative sea level is 0.2m

21

it is very unlikely to be less than 0.1m and is very unlikely to be more than 0.4m.

Climate Change - UKCP09

Predictions – Key findings for NW England 2080s

High emissions scenario – central estimate

Temperature

Increase in winter mean temperature is 3.1°C
it is very unlikely to be less than 1.9°C and is very unlikely to be more than 4.8°C.

Increase in summer mean temperature is 4.7°C
it is very unlikely to be less than 2.5°C and is very unlikely to be more than 7.3°C.

Increase in summer mean daily maximum temperature is 6°C
it is very unlikely to be less than 2.3°C and is very unlikely to be more than 10.1°C.

Precipitation

Change in annual mean precipitation is 1%
it is very unlikely to be less than –10% and is very unlikely to be more than 12%.

Change in winter mean precipitation is 26%
it is very unlikely to be less than 9% and is very unlikely to be more than 50%.

Change in summer mean precipitation is –28%
it is very unlikely to be less than –51% and is very unlikely to be more than -2%.

Sea Level

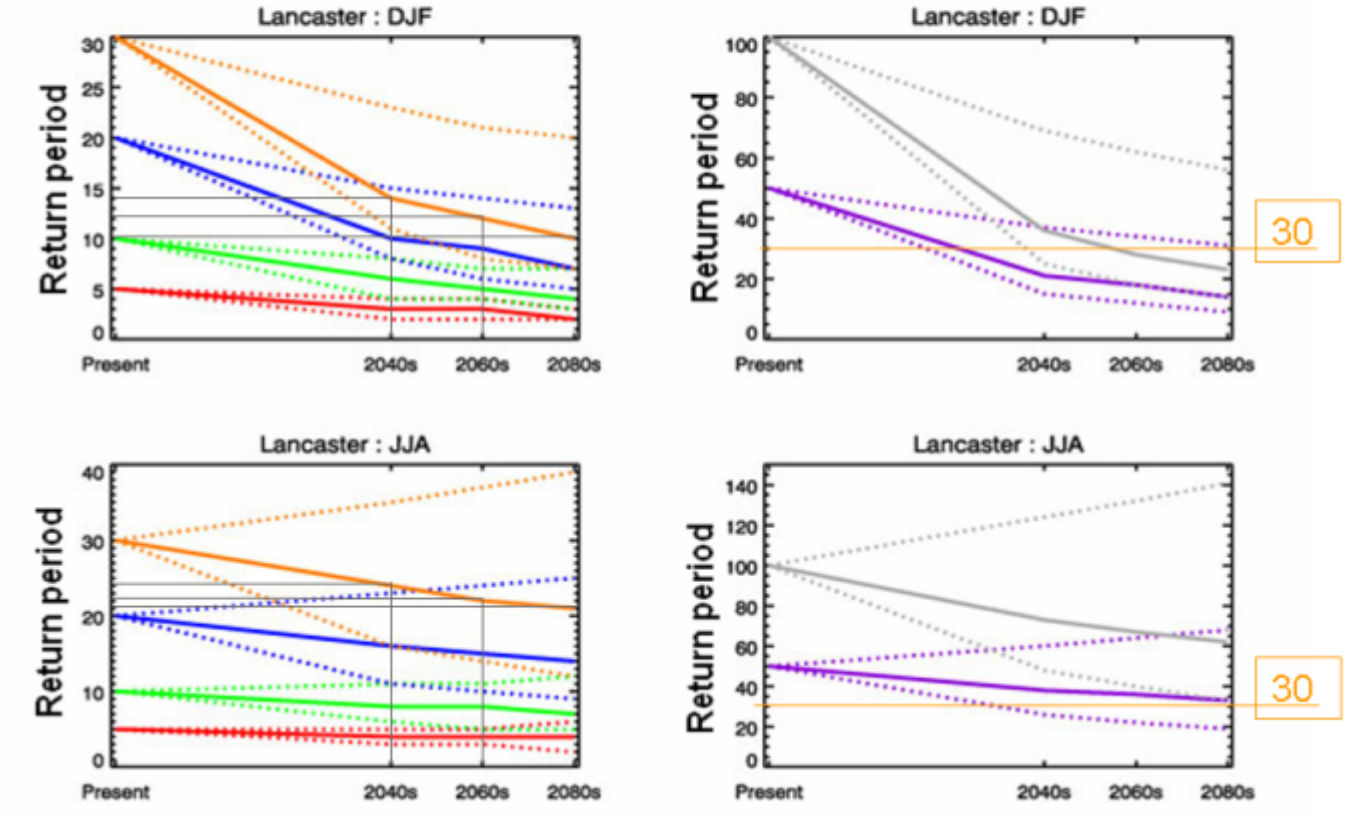
Change in relative sea level is 0.4m
it is very unlikely to be less than 0.1m and is very unlikely to be more than 0.6m.

22

Ofwat – Met Office (Report on change in freq. of extreme rainfall)

Lancaster

Note
All data based on using the MEDIUM Emissions scenario



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APPENDIX C. DEFRA STATUTORY GUIDANCE BOX 2

www.defra.gov.uk

Adapting to Climate Change: helping key sectors to adapt to climate change

Statutory Guidance to Reporting Authorities 2009

Box 2. What to include in a report?

1. Functions impacted by climate change

a. What are your organisation's functions, mission, aims, and objectives?
b. Which of these will be affected by the current and possible future impacts of climate change?
c. Have you assessed the climate thresholds above which climate change and weather events will pose a threat to your organisation? If so what were the main results?
d. Who are your organisation's key stakeholders? Do you need to assess the impacts of climate change on them?

2. Approach

a. What evidence, methods and expertise have you used to evaluate future climate impacts? List sources and references.
b. How do you quantify, or otherwise estimate or characterise the impact and likelihood of risks occurring at various points in the future?
c. How have you evaluated the costs and benefits of proposed adaptation options?

3. Summary of risks which affect functions, mission, aims, and objectives

a. List all the organisations' strategic risks from climate change on a likelihood/consequence matrix – including thresholds where applicable.
b. What short and long term impacts of climate change have you identified and how are each factored into the adaptation programme? Quantify the likelihood and consequences as far as possible (including an assessment of the level of confidence (e.g. high/medium/low) in the calculations) and disaggregate these risks to different locations where appropriate.
c. What are your high priority climate related risks and why (stating level of impact to business, likelihood, costs and timescales)?
d. What opportunities due to the effects of climate change which can be exploited, have been found?

4. Actions proposed to address risks

a. What are the adaptation actions for the top priority risks (stating timescales)?
b. How will the adaptation actions be implemented (stating level of responsibility, investment and timescales)?
c. How much do you expect these adaptation measures to cost and what benefits do you anticipate will result from them?
d. How much do you expect them to reduce risk by, and on what timescales?

e. How will you ensure the management of climate change risks is embedded in your organisation?

5. Uncertainties and assumptions

a. What are the main uncertainties in the evidence, approach and method used in the adaptation programme and in the operation of your organisation?
b. What assumptions have been made when devising the programme for adaptation?

6. Barriers to adaptation and interdependencies

a. What are the barriers to implementing your organisation's adaptation programme?
b. How will these barriers be addressed?
c. What/who are the interdependencies (including the stakeholders stated in response to question 1d)?

7. Monitoring and evaluation

a. How will the outcome of the adaptation programme be monitored?
b. How will the thresholds, above which climate change impacts will pose a risk to your organisation, be monitored and incorporated into future risk assessments?
c. How will the residual risks of impacts from climate change on your organisation and stakeholders be monitored?
d. How will you ensure that the management of climate change risks is firmly embedded in your organisation?
e. How will you enable your management of climate change risk to be flexible?
f. Has the production of this report led to a change in your management of climate risks?

APPENDIX D. CRANFIELD EVALUATION FRAMEWORK

Cranfield UNIVERSITY

Evaluating the risk assessments of Reporting Authorities under the Climate Change Act 2008

defra
Department for Environment Food and Rural Affairs

Collaborative Centre of Excellence for Understanding and Managing Natural and Environmental Risks

August 2010

Table 1-5. Attributes and sub-attributes of the evaluation framework and links to the Statutory Guidance.

Key attribute[34]	Sub-attribute:	Statutory Guidance reference
1. Climate change risk assessment is a clear component of corporate risk appraisal	1.1 Climate change demonstrably a key consideration in corporate planning and processes of the Reporting Authority	§1.10; §1.11; Annex B, 1.
	1.2 Reporting Authority presents a clear analysis of climate risks on business operations for specified periods into the future and includes high priority climate related risks and timescales	§3.2 Box 1; §3.11 Box 2; Annex C Table 2
	1.3 Adaptation plan is clearly embedded in the core of the Reporting Authority's business	§3.2 Box 1; §3.11 Box 2; Annex B, 2; Annex C Table 2
	1.4 Reporting Authority includes some prior evaluation of how its climate change risks impact upon or are affected by stakeholders	§3.11 Box 2
	1.5 Reporting Authority considers the existing policies and procedures related to climate impacts, and the effect the weather has on operations and the achievement of the organisation's strategic objectives	§4.6

[34] Not every authority is expected to follow the risk assessment approach (Annex C of the Statutory Guidance) in its entirety and it is up to the authority to determine what works best for them (§4.2); where adaptation requires a long lead time, the authority should highlight that it has begun to investigate adaptation options or has included them in its future work programme (§5.7).

2. Climate change risk assessment enables the Reporting Authority to make evidence based decisions on adapting to climate change	2.1 Reporting Authority adopts a conceptual risk management framework for organisational, rather than locational risks	§3.11; Annex C
	2.2 Reporting Authority identifies the key climate variables and their potential impact on the organisation	§3.2 Box 1; §4.1; Annex B, 6.
	2.3 Reporting Authority provides clear criteria for likelihood and consequence that are appropriate and specific to their organisation	§3.2 Box 1; Annex B, 4;
	2.4 Reporting Authority's risk assessment quantifies, or otherwise estimates or characterises the impact and likelihood of risks occurring at various points in the future	§3.11 Box 2; §4.14
	2.5 Reporting Authority presents all the organisation's strategic risks from climate change on a likelihood/consequence matrix, where possible including the climate thresholds above which climate change poses a threat to the organisation. Where it is not possible, the Reporting Authority should set out how it will investigate thresholds.	§3.11 Box 2; §3.2 Box 1; §4.10
	2.6 Reporting Authority considers short, medium and long term risks of climate change disaggregated into different locations where appropriate, and includes an assessment of the level of confidence in these calculations	§3.11 Box 2; §4.1; §4.12
3. Demonstrable use of relevant and appropriate data, information, knowledge, tools and methodologies	3.1 Reporting Authority adopts the latest set of UK Climate Projections (currently UKCP09) or other appropriate scenarios or climate information	§2.9; §4.4; Annex C Table 2
	3.2 Reporting Authority demonstrably assesses using the best evidence suitable to organisational need	§3.2 Box 1; §4.11; Annex B, 3
	3.3 Reporting Authority's risk assessment includes consultation with interested parties or stakeholders	§1.16
4. Climate change risk assessment and adaptation measures explicitly consider uncertainties	4.1 Reporting Authority's risk assessment includes a statement of the main uncertainties in the evidence, approach and method used in the adaptation plan and in the operation of the organisation	§3.11 Box 2; Annex B, 5
	4.2 Reporting Authority's adaptation responses explicitly account for uncertainties and interdependencies of actions, including the actions of others on the adaptation plan	§3.2 Box 1

	4.3 Reporting Authority's adaptation plan includes a clear statement of assumptions which are well evidenced and justified	§3.11; Box 2; §3.14
5. Climate change risk assessment generates priorities for action	5.1 Reporting Authority provides priority areas for action that are demonstrably linked to the development of a risk-based adaptation plan	§3.2 Box 1; §4.2; §4.7; §4.9; §5.1; Annex C Table 2
	5.2 Reporting Authority's adaptation plan includes a detailed action plan covering its priority areas. This should ideally include timescales, resources and responsibilities and be included in the report[35].	§5.6; §5.7
	5.3 Reporting Authority's risk management actions are targeted to demonstrably reduce risks to a defined (by the organisation) level of residual risk	§3.2 Box 1
	5.4 Reporting Authority's adaptation plan is subject to appraisal against sustainability principles, and specifically to an appraisal of costs and benefits	§3.2 Box 1; §3.11 Box 2; §5.2; §5.5; §5.8; §5.9; §5.10; §5.18; §5.20; §5.23; §5.24

6. Climate change risk assessment identifies opportunities (where applicable)	6.1 Reporting Authority's risk assessment allows an evaluation of net benefits and/or opportunities arising from the impacts of climate change	§2.15; §2.17; §3.11 Box 2; §5.14; §5.21
7. Clear demonstration of flexible adaptation measures	7.1 Reporting Authority's adaptation plan includes strategies to deal with the level of quantified risk and retains flexibility over which future course of action to follow as knowledge improves and projections change	§4.15; §5.11; §5.12; §5.13; §5.14; §6.8; §6.10

[35] Where this is not possible, (e.g. to avoid duplication with your corporate risk register or for commercial/confidentiality issues) this should be explained and the action plan made available for Cranfield to review during the evaluation process if necessary.

	7.2 Reporting Authority's adaptation plan includes a statement of the barriers to implementation and a means for overcoming these	§3.11 Box 2
8. Monitoring and evaluation of adaptation effectiveness	8.1 Where possible, the Reporting Authority's report shows progress already made against its adaptation plan	§3.1
	8.2 Reporting Authority makes clear provision for the evaluation of the effectiveness and viability of its adaptation plan	§3.2 Box 1; §3.11 Box 2; §6.3; §6.6
	8.3 Reporting Authority makes clear provision for monitoring thresholds, above which climate change impacts will pose a risk to the organisation, and their incorporation into future risk assessments[36].	§3.11 Box 2
	8.4 Reporting Authority makes clear provision for the monitoring of residual risks from climate change on the organisation and its stakeholders	§3.11 Box 2; §5.1
	8.5 Reporting Authority offers evidence that the production of the risk assessment and adaptation plan has led to a change in the organisation's management of climate risks	§3.11 Box 2

[36] Where thresholds are not known, a clear commitment to address this should be made wherever possible.